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Physico-Chemical Analysis of Abattior Effluent Contaminated Soil in Ikpoba, Benin, Edo State

Akinyeye AJ, Solanke EO and Akinmolayan OA

Department of Biological Sciences Igbinedion University, Okada, Edo State, P.M.B 0006, Benin City, Edo State, Nigeria

ABSTRACT

The physico-chemical analysis of abattoir effluent contaminated soil in Benin (Ikpoba-Okha Local Government Area), Nigeria was investigated. Five soil samples were collected from two abattoirs study area and uncontaminated area was used as control. The physico-chemical parameters investigated include; soil pH, Carbon, Nitrogen and available phosphorus content, exchangeable bases (Na, K, C and Mg) and soil particle size using the standard technique. The abattoir effluent contaminated soils have the mean pH values between 6.30 and 6.33 and showed high significant difference in pH values compared to uncontaminated soil at 5% level of probability. The organic carbon content of abattoir effluents contaminated soils ranged between 1.57% and 1.54% this also showed significant difference at 5% level of probability. Exchangeable bases (Na, K, Ca and Mg) contents values obtained in the contaminated soils have much lower value compared to uncontaminated soil. Generally, the exchangeable bases contents values for the contaminated study area showed significant difference from uncontaminated study area except for the potassium values. Analysis of variance (ANOVA) at p=0.05 was used to further determines the differences among the factor investigated.

Keywords: Contaminated soil, Abattoir effluent, Soil parameters.

Corresponding author

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INTRODUCTION

An abattoir has been defined as a premise approved and registered by the controlling authority for hygienic slaughtering and inspection of animals, processing and effective preservation and storage of meat products for human consumption [1]. Animals slaughtered include cattle, sheep, pigs, goats and other equine animals. The killing of anneals for community consumption is inevitable in most nations of the world and dated back to antiquity.

Abattoirs generate large amounts of solid waste and effluents such as rumen contents, blood and waste water. Abattoirs often have difficulties in disposing of the solid wastes and wastewater in an environmentally acceptable fashion and in many instances untreated rumen contents, blood and/or other Abattoir effluents and wastewater are released into the environment. The resulting pollution not only cause problems related to odour, flies and hygiene, but surface and ground water can be polluted with pathogens and undesirable chemical compounds.

One of the effects of waste water source draining into the soil is making the soil oxygen to become less available as an electron acceptor, prompting denitrifying bacteria to reduce available nitrate to gaseous nitrogen which enters the atmosphere with resultant negative effects. Also, the anaerobic archae (methanogens) may produce excessive methane at a higher rate than aerobic methane oxidizing bacteria (methanotrophs) could cope with, thus contributing to greenhouse effect and global warming. Similarly, the physicochemical properties of the soil may become altered, such as the pH, due to the uncontrolled discharge of untreated abattoir wastewater resulting in the loss of certain soil microbes [2].

MATERIALS AND METHODS

Sample Collection

Soil samples were collected from two abattoirs with sterile polyethylene bags. The abattoirs were located in Ikpoba hill (Ikpoba-Okha Local Government) Benin, Edo State, Nigeria. Both abattoirs were adjacent to each other. Soil samples were collected from abattoir contaminated area and the neigbhourhood without wastewater contamination to serve as control. Benin abattoirs were chosen for soil sample collection because slaughtering activities was relatively higher and the abattoirs were well demarcated with fence. Whatever contamination observed from the soil samples can primarily be attributed to the wastewater. Five samples were collected from each site. All samples were well labeled and transported to the laboratory for analyses immediately after collection. There were a total of 5 replicates for each sample.

Analysis of soil for physic chemical parameters

Physio-chemical parameters of soil samples were analyzed before and after the experiment. The parameters determined include, pH, carbon (C), Nitrogen (N), Phosphorus (P),

Sodium (Na), Potassium (K), Calcium (Ca), and Magnesium (Mg) contents and particle size analysis.

Soil pH

The pH is the measure of the hydrogen ion concentration in the sample. The pH values of the samples were determined using pH meter 3015 (Jenway, U.K.). Ten grams of the soil sample was placed in a beaker, then 10ml of distilled water was added and the mixture was stirred. It was allowed to stand for 30 minutes. A 0.1 M phosphate buffer solutions was used to standardize the pH meter. Then the electrode of the pH meter was inserted into the mixture and the pH readings were taken.

Soil particle analysis

Soil particle analysis was determined by Hydrometer method as described by [3]. One hundred gram of air dried soil sample was weighed into a 1000ml plastic beaker and treated with hydrogen peroxide (H_2O_2) to destroy the organic matter. Two hundred ml of distilled water and 100ml of sodium hexa metaphosphate solution were added to the treated soil sample and stirred with glass rod. The plastic beaker was covered and kept for 4hours. The volume of the content was made up to 500ml and stirred for 10minutes. The whole contents were transferred to a suspension cylinder and the volume was made up to 1000ml with distilled water. The cylinder was tightly closed with stopper and shake for several times to allow the soil particles to disperse completely. The stopper was removed and hydrometer was immediately placed in the suspension. The first reading was taken exactly 40seconds after placement of hydrometer. The cylinder was closed with the stopper and inverted several times again to ensure complete dispersal of particles. The hydrometer was placed in the suspension exactly after 2hours and the second reading was noted. The blank was simultaneously run without soil and the room temperature was recorded.

Organic carbon

Organic carbons were determined by the chronic acid titration method as described by [4]. One gram of soil samples were weighed into a 500ml conical flask, 10ml of 1N potassium dichromate (1N $K_2Cr_2O_2$) and 20ml of concentrated sulphuric acid (conc. H_2SO_4) was added in order to oxidize the organic carbon. The flask was swirled carefully and allowed to stand for 30minutes. Two hundred ml (200ml) of distilled water and 10ml of concentrated orthophosphoric acid (conc. H_3PO_4) were slowly added. One ml (1ml) of diphenylamine indicator was added before titrated against 0.5N ferrous ammonium sulphate solution until green colour started appearing, indicating the end point. The blank was run simultaneously.

Nitrogen (Kjeldhal method)

The total nitrogen was determined by Kjeldhal method. Five grams of air dried soil samples were weighed into digestion tube and moist with distilled water. Twenty ml (20ml) of

concentrated sulphuric acid (Conc.H_2SO_4) and 5g of catalyst (Mixture of K_2SO_4) and Se (5g: 5mg respectively) were added. The tubes were then placed in the digestion unit. The heating equipment was adjusted to 400^oC and tubes were heated till the mixture became transparent, the tubes were allowed to cool. Forty percent sodium hydroxide (40% NaOH) was added to the digest till the colour changed blackish and the contents were distilled. The distillates (liberated ammonia) were collected into 10ml of 2% boric acid solution (H_3SO_4) until pink colour started appearing. A blank without the soil was run for each set of samples.

Phosphorus

The available phosphorus was determined using Bray's method for acid soils. In this method, 2g of soil sample was weighed into a 50ml shaking bottle and 14ml of extractant was added. The mixture was shaken for one minute by hand and immediately filtered with Whatmann number 42 filter paper. One ml filterate was pipette into a test tube and 2ml of boric acid was added. The contents were shaken and left for 1hour for the blue colour to develop. The concentration of the solution was measured at 490nm using spectrophotometer.

Determination of Cation exchange capacity (CEC) by Silver thiourea method

Five grams of well ground air dried soil sample was weighed into 50ml centrifuge tube. Thirty ml (30ml) of silver thiourea reagent was added and mixture shaken on a mechanical shaker for 2 hours. The mixture was set at 2000rmp for 10minutes on a centrifuge. The supernatant was carefully decanted into 100ml conical flask. Potassium (K^+) and sodium (Na^+) were determined in the extract by aspirating into a flame photometer, while magnesium (Mg^{2+}) and calcium (Ca^{2+}) were determined by aspirating the same extract into atomic absorption spectrophotometer (AAS) at their respective wavelength.

Data analysis

The data generated was subjected to Analysis of Variance (ANOVA) and Duncan's Multiple Range (DMR) test was used to established significant differences among the treatments at 5% confidence limit using SPSS (version 17.0) statistical package.

RESULT AND DISCUSSION

Soil Analysis

The results of the physicochemical analyses of abattoir effluents contaminated soils and non-contaminated soil are presented in Table 1. The particle size analysis showed that the soil of the study area is sandy soil.

The abattoir effluent contaminated soils A and B had mean pH values of 6.33 and 6.30 respectively, while the mean pH value of unpolluted soil was 4.97 (Table 1). The abattoir

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effluents contaminated soil showed high significant difference in pH values compared to uncontaminated soil at 5% level of probability.

Organic carbon content of abattoir effluents contaminated soils are 1.57% and 1.54% respectively, whilst that of the uncontaminated soil was 1.48%. Although, the percentage carbon contents of abattoir effluents contaminated soils showed significant difference at 5% level of probability (Table 1).

The available phosphorus content of the abattoir effluents contaminated soils were 18.21mg/kg and 16.21mg/kg respectively, whilst that of uncontaminated soil was 7.23mg/kg. Although, abattoir effluents contaminated soil A available phosphorus contents value was higher and showed significant difference from the value obtained from abattoir effluents contaminated soil B, both study area showed significant difference from uncontaminated soil area.

Exchangeable bases (Na, K, Ca and Mg) contents obtained in the contaminated soils have much lower value compared to uncontaminated soil (Table 1). The contents of exchangeable Na in contaminated soils of the study area were 0.18meq/100g and 0.20meq/100g respectively whilst that of uncontaminated soil was 0.54meq/100g. The K contents in contaminated area were (0.06 and 0.08) meq/100) respectively whilst that of uncontaminated soil was 0.11meq/100g. The Mg contents in contaminated area were (1.01) and 1.07)meq/100 respectively whilst that of uncontaminated soil was 2.24meq/100g. Generally, the exchangeable bases values for the contaminated study area showed significant difference from uncontaminated study area except for the potassium values.

Table 1: Physiochemical parameters of soil contaminated with abattoir effluents and uncontaminated (control)

Parameters	Uncontaminated soil	Contaminated Soil A	Contaminated Soil B
pH (H_2O)	$4.97^{a} \pm 0.059$	$6.33^{b} \pm 0.132$	$6.30^{b} \pm 0\ 139$
Carbon (%)	$1.48^{a} \pm 0.018$	$1.57^{b} \pm 0.016$	$1.54^{a} \pm 0.042$
Nitrogen (%)	$0.097^{a} \pm 0.006$	$0.14^{b} \pm 0.009$	$0.16^{b} \pm 0.015$
Phosphorus (mg/kg)	$7.23^{a} \pm 0.079$	$18.21^{c} \pm 0.838$	$16.21^{b} \pm 0.703$
Sodium (meq/100g)	$0.54^{b} \pm 0.068$	$0.18^{a} \pm 0.027$	$0.20^{a} \pm 0.015$
Potassium (meq/100g)	$0.11^{b} \pm 0.016$	$0.016^{a} \pm 0.007$	$0.08^{ab} \pm 0.007$
Calcium (meq/100g)	$3.24^{b} \pm 0.304$	$1.52^{a} \pm 0.054$	$1.37^{a} \pm 0.255$
Magnesium (meq/100g)	$2.24^{b} \pm 0.058$	$1.01^{a} \pm 0.024$	$1.07^{a} \pm 0.013$
Sand (%)	87.5	89.2	89.5
Silt (%)	6.3	3.7	5.9
Clay (%)	6.2	7.1	4.6

Mean with the same letter in a row are not significantly different at 5% level of probability from one another
$\pm$ Standard Error (S. E).

The soil particle analysis result showed that the soil of the study areas were sandy. The soil is acidic as reflected by the low mean pH value (4.97 ± 0.059) obtained from the control (uncontaminated soil). The man pH value obtained from the abattoir effluents contaminated soil (6.33 ± 0.132 and 6.30 ± 0.139 respectively) showed high significance difference compared

to control which reflected that abattoir effluent has greater influence on the pH value of the receiving soil. The rise in the pH value of soils towards neutrality with application of abattoir effluent has been reported by [6].

The organic carbon content, total nitrogen and available phosphorus of the polluted soil were significantly higher than that of the unpolluted soil. This could be attributed to waste release from slaughter houses because these wastes are rich in organic matter. The increase in available phosphorus may have been due to the moderate rise in pH, which could enhance the availability of phosphorus. These factors may play a crucial role in determining both the quantitative and qualitative abundance of microorganisms in the contaminated soil [6, 7].

The exchangeable bases (Ca, Mg, K, and Na) contents values obtained from the contaminated soils were significantly lower than that obtained from uncontaminated soil. This may have been borne out of immobilization of these elements by soil microorganism. These findings were in accordance with the [5], who reported that abattoir effluents reduced exchangeable bases in the polluted soil and accounted for 85% of the variation in base saturation.

CONCLUSION

Generally, the result showed high significant reduction in exchangeable bases compared to control, whilst available phosphorus, carbon and nitrogen contents were significantly increased. Abattoir effluent raised the pH level of the soil from strongly acidic to moderately acidic. All these factors could play a major role in the disequilibrium of microbial and other constituents of the contaminated soil.

The results of this finding revealed that untreated abattoir waste indiscriminately released into the environment could pose a health risk and bring about the ecological imbalance to the receiving environment through;

- The alteration of normal soil organisms in the receiving environment.
- The high proportion of mineral nutrients such as nitrogen and phosphorus contents of abattoir waste which can induce eutrophication processes in the receiving system.

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