Scholars Academic Journal of Biosciences (SAJB) **ISSN 2321-6883 (Online)**
Sch. Acad. J. Biosci., 2015; 3(5):452-455 **ISSN 2347-9515 (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublishers.com **DOI :** 10.36347/sajb.2015.v03i05.006

Research Article

Effect of Abbatoir Waste Water on Soil Microbial Communities

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Abstract: The microbial population in soil contaminated with abbatoir waste water was investigated. The results revealed high bacterial and fungal counts in Rumuokoro waste water (Rw), soil (Rs) , Emenike wastewater (Ew) and soil (Es). The bacterial counts in Rw and Ew were 1.12 x 10^7 and 2.04 x 10^7 cfu/ml while Rs and Es were 4.6 x 10^7 and 7.6 x 10^7 cfu/g respectively. The fungal counts for Rw and Ew were 1.5 x 10^6 and 2.1 x 10^6 cfu/ml while Rs and Es were 6.0 x 10^6 and 9.0 x 10^6 cfu/g respectively. The control soil sample had lower bacterial and fungal counts of 2.7 x 10^4 and 1.2 x 10^3 cfu/g respectively. The following genera of bacteria were isolated*: Escherichia coli* , *Staphylococcus aureus* ,*Streptococcus faecalis*, *Campylobacter*, *Pseudomonas* and *Klebsiella* spp while the fungi were *Aspergillus niger*, *Aspergillus fumigatus*, *Aspergillus flavus* , *Mucor pusillus* and *Penicillium* spp . The physicochemical characteristics of Rumuokoro and Emenike Abbatoir waste water was as follows: temperature (26◦c and 27◦c), pH (5.1 and 5.2 mg/l),dissolved oxygen (1.2 and 1.2mg/l), biological oxygen demand (123 and 125 mg/l), chemical oxygen demand (242 and 245 mg/l) total suspended solid (910 and 915 mg/l), total dissolved solid (640 and 660 mg/l) ,conductivity (3125 and 3128/cm) respectively. The contaminated soil samples had the following physicochemical characteristics: pH (7.3 and 8.2) ,temperature (30◦c and 33◦c), Cation Exchange Capacity (CEC)(18.56 and 18.70 %), nitrogen concentration (0.25 and 0.28mg/g). The results showed that there were no significant differences at 0.05 confidence limits between the bacterial counts in the Rumuokoro and Emenike abbatoir waste water and soil. The same result was also obtained in the fungal counts in the abattoirs and soil samples.
Keywords: Rumuokoro, Emenike,Abbatoir, soil, wastewater,physicochemical, bacteria, fungi

INTRODUCTION

An abattoir or slaughter house is a specialized environment where meat processing is usually carried out. It is a place or building where animals are killed for their meat[1]. The meat industry uses large quantity of wastewater that drains into surrounding soil environments [2]. Abattoir activities are aimed at optimizing the recovery of edible portions of the meat processing cycle for human consumption. Abattoir wastes are hazardous wastes and however, significant quantities of secondary waste materials such as blood, fat, organic and inorganic solids, salts and chemical wastes are generated during this process [3]. Various organs of cattle such as muscles, liver, kidney, viscera and hair have been found to contain heavy metals [4]. Tortora *et al.,* reported [5] that following the discharge of untreated wastewater into the soil, certain elements (for example, iron, lead, phosphorus, calcium, and zinc) previously absent or present in minute quantities will be introduced into the environment leading to the magnification of these chemicals, thus altering the physicochemical nature of the soil. Some of these chemicals may be toxic to the microbial flora and fauna communities of the soil. Abattoir waste water has a complex composition and can be very harmful to the environment. For example, improper disposal of paunch manure may exert oxygen demand on the receiving environment or breed large population of decomposers (micro-organisms) which may be pathogenic.

Furthermore, improper disposal of animal feces may cause oxygen-depletion in the receiving environment. It could also lead to nutrient over enrichment of the receiving system and increased rate of toxins accumulation in biological systems [6]. Therefore, the aim of this study is to investigate the effect of abbatoir waste water on soil microorganisms and the physico-chemical qualities of the soil surrounding the Rumuokoro and Emenike abattoirs contaminated with the discharged abattoir wastewater.

MATERIALS AND METHODS

Source of waste water and soil samples

Waste water samples were collected from two (2) abattoirs with sterile container. The abattoirs were located in Rumuokoro and Emenike (Diobu), both within Rivers State, Nigeria. Sample collection was

carried out according to methods described by Adesemoye *et al.*, [7]. Twenty grams (20g) of soil contaminated with abbatoir waste water were collected in sterilized cellophane or polythene bags. Contamination observed from the soil samples was therefore attributed to the waste water. All samples were well labeled and transported to the laboratory for analysis immediately after collection. The samples used as control were collected from areas devoid of butchering activities.

Physicochemical analyses

The physicochemical parameters of soil and waste water samples were determined using Association of Official Analytical Chemists [17] method.

The pH of the waste water was determined using the Jenway pH meter (3015 model). The mercury thermometer was used to determine temperature. Other parameters like dissolved oxygen, salinity, conductivity, total dissolved solid ,total suspended solid, nitrate, phosphate, ammonia and sulphate were monitored as described in APHA,[8]. For the soil samples, pH, temperature, cat ion exchange capacity (CEC) and nitrate were determined.

Bacteriological Analyses

The total heterotrophic bacterial count was performed in duplicates on dried nutrient agar plates and incubated 30◦c for 24hrs. At the end of the incubation period, isolation for pure culture was done.

Acidified potato dextrose agar plates containing streptomycin (1mg/100ml) were used to obtain fungal isolates. The plates were incubated at 30◦c and observed after 48 hours for yeasts and 96 hours for mould, after this, isolation of pure isolates was done.

Identification and Characterization of isolates

The methods described in Cheesebrough [9] were adopted in characterization of isolates. Isolates were identified by standard methods [10].

Statistical Analysis

Results were subjected to statistical analysis employing the student t-test at 95% probability levels using SPSS (VERSION 14.0) statistical package.

RESULTS

The uncontaminated soil (control) had the following bacterial and fungal counts: 2.7×10^4 and 1.2×10^3 cfu/g respectively. The total heterotrophic bacteria counts in Rumuokoro Abattoir waste water (Rw),soil (Rs), Emenike waste water (Ew) and soil (Es) is shown on Figure 1.

The total fungal count in Rw, Rs, Ew and Es is shown on Figure 2.

The results of the physicochemical parameters of the waste water and contaminated soil from the Rumuokoro and Emenike abattoirs are shown on Table-1.

The results of physicochemical parameters of the uncontaminated and contaminated soil from Rumuokoro and Emenike Abattoirs are shown on Table-2.

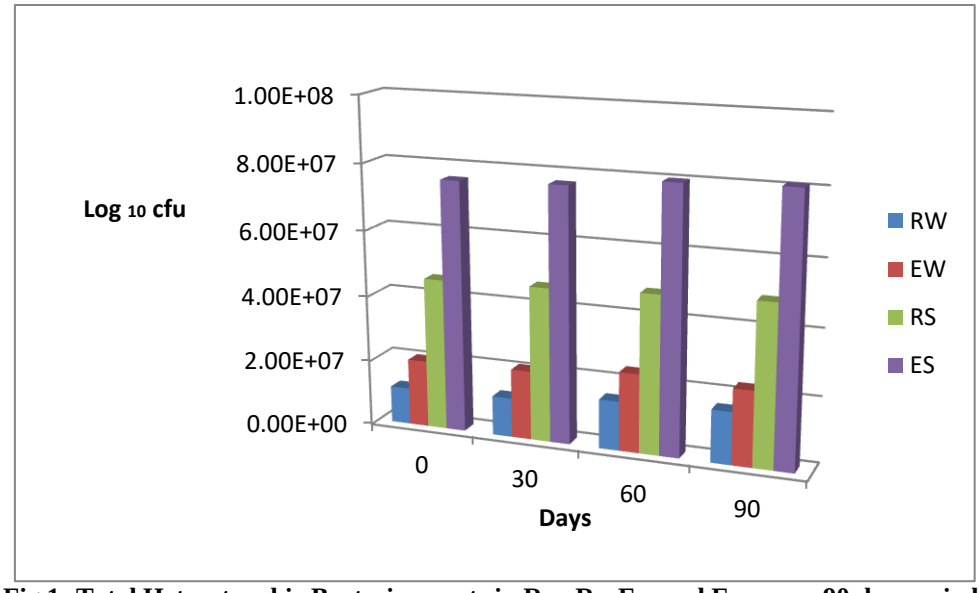

Fig 1: Total Heterotrophic Bacteria counts in Rw, Rs, Ew and Es over a 90 day period.

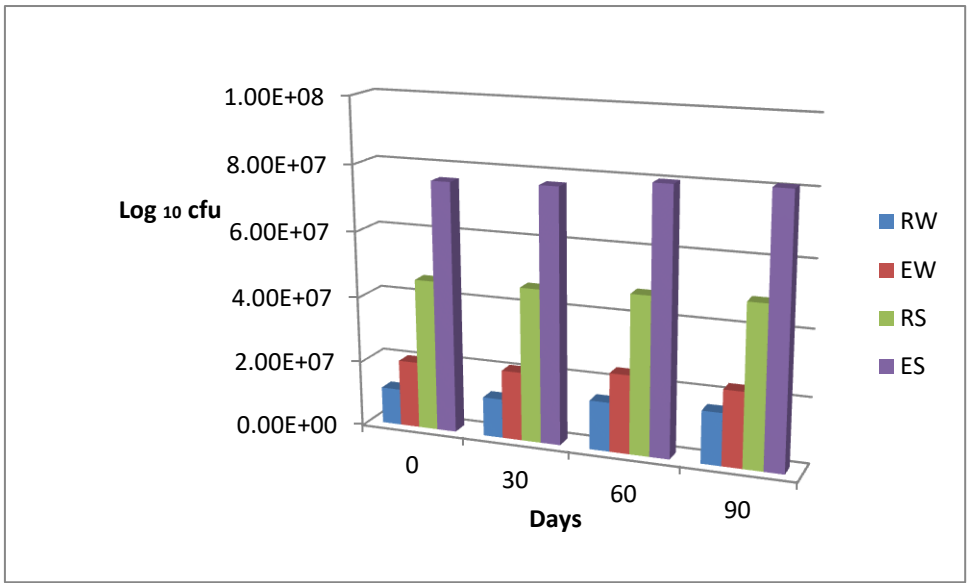

Fig.2 : Total Fungi count in Rw, Rs, Ew and Es over a 90 day period.

Table 1: Physicochemical parameters of abattoir waste water from two locations

Parameters	Location of abattoir Rumuokoro	Waste water Emenike
pH	5.1	5.1
Temperature (◦C)	26	27
Dissolved Oxygen(mg/l)	1.2	1.2
Biological Oxygen Demand (mg/l)	123	125
Chemical Oxygen Demand (mg/l)	242	245
Total Suspended Solid (mg/l)	910	915
Total Dissolved Solid (mg/l)	640	660
Conductivity (µs/cm)	3125	3128

Table 2: Physicochemical parameters of soil contaminated with abattoir waste water and uncontaminated soil (control)

	Contaminated Soil		Uncontaminated Soil
Parameters	Location of abattoir Rumuokoro	Waste water Emenike	Control
pH	7.3	8.2	8.0
Temperature (◦C)	30	33	30
Nitrogen Concentration (mg/g)	0.25	0.28	0.42
Cation Exchange Capacity (%)	18.56	18.70	13.3
Organic matter Content (%)	11.5	11.8	3.25
Magnesium (mg/g)	2.65	2.67	2.30
Phosphorus (mg /g)	5.5	5.55	5.1
Potassium (ppm)	1958	1960	285
Calcium (ppm)	76	80	65

DISCUSSION

The high bacterial and fungal counts obtained in the contaminated soil in both Rumuokoro and Emenike indicated that they had a high population density than the control soil. There was a significant difference between the counts in the contaminated soil in comparison to the uncontaminated soil. The waste water from the abattoirs may contain growth fact ors that could be utilized by the organisms found in these contaminated sites and unavailable in the uncontaminated soil, hence, the high microbial counts. Contamination due to discharge of waste into the soil ecosystem might have resulted in the destabilization of the soil ecological balance. Rabah et al.,[11] and Adesemoye *et al.*,[7] reported similar high counts of 3.7×10^6 and 3.36×10^7 cfu/g of bacteria of waste water

contaminated soil samples in Sokoto and Lagos states in Nigeria abattoirs respectively. The presence of *E. coli* and *Streptococcus faecalis* in the contaminated soil samples could be attributed to the great amount of animal excreta in the wastewater. This is an indication of recent fecal pollution. Similar findings were reported by Bala[12] of the isolation of similar organisms from water sources in Jimeta-Yola that were faecally contaminated. *Escherichia coli, Staphylococcus aureus and Pseudomonas species* are microorganisms that inhabit the skin and stomach of the animals being slaughtered as normal flora. *Aspergillus species* secrete a toxin known as mycotoxins which are poisonous to human health. Most of the fungal isolates are soil-inhabiting microorganisms [13] as well as common spoilage organisms associated with beef industry [14]. The presence of these organisms is a pointer to pollution and may have an effect on the soil ecological balance. These findings were in conformity to that of Ogbonna and Igbenijie [15]. The two abattoirs waste water and soil samples indicated that Emenike abattoir had the highest bacterial and fungal counts. The physicochemical parameters studied in Rumuokoro and Emenike abattoirs showed that the dissolved oxygen, pH, Temperature were equivalent or below FEPA [16] permissible limits of 4mg/L, 6.5-8.5, respectively. The biological oxygen demand, total suspended solid, total dissolved solid, chemical oxygen demand of the abattoirs waste water were higher than WHO recommended standard limits of 20mg/L, 20mg/L, 200mg/L, 1000mg/L respectively. Such elevated value of total suspended solid in the abattoir waste water might be attributed to various materials of solid waste from the slaughtered animals. The result from the statistical analysis ($P>0.05$) indicates that there was no significant difference between the bacterial and fungal counts of Rumuokoro and Emenike abattoir waste water and soil. There was no significant difference ($p>0.05$) in the values obtained for temperature, magnesium, nitrogen and phosphorus in the contaminated soil and the control but a significant difference ($p<0.05$) existed in the values obtained for cation exchange capacity, potassium ,calcium and organic matter content for the values obtained for the contaminated soil to that of the uncontaminated soil. Despite the fact that these values were higher than that of the control sample, they are below the limit set by the Federal Ministry of Environment. Similar low values of these chemicals were observed by Rabah *et a*l.,[11] in Abattoir effluents. The contaminated soil contained a number of chemicals though in small quantities and this is consequent upon high microbial activities in such soil. Therefore, it is highly recommended that the abattoir effluents should be treated before being discharged into the surrounding environments.

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