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Characterization of Contaminated Abattoir Soil in Swali Market Bayelsa State

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Abstract

The waste effluents and waste from abattoirs have been documented to have harmful effects on the soil media, which causes threat to the living organisms and its surrounding, hence the need to characterize the contaminated abattoir soil in Swali market. Soil samples were characterized for possible contamination of physicochemical parameters and heavy metals. Six (6) soil samples were collected for six weeks at different points radially, the control was from a well of 160m from the abattoir, remaining five (5) samples were collected from different points which are 2m away from the abattoir with the depth of 0.5m and 2m apart in cyclic. The soil samples were taking to the laboratory for digestion, and the analysis. The physicochemical parameters result showed that; pH (3.8-6.3), conductivity (56-462) µ, temperature (29) OC, TDS (38-332) ppm, SO4 (343.32-2403.24) mg/l, HCO3 (0.2-8.05) mm/l, D.O (5.1-6.3) mm/l, B.O.D (0.1-0.2) mm/l, Alk (75-250) mg/l, Acidity (50-755), while the result of heavy metals indicated; Pb (0.39-0.73) mg/l, Cr (0.06-0.113) mg/l, Mg (1.22-1.79) mg/l, Co (0.25-0.92) mg/l, Co (0.25-0.92) mg/l and Fe (2.13-8.45) mg/l/. The results were compared with FEPA and WHO standards and validated with ANOVA using Python 3.6 version and SPSS software of version 20 in other to compare the values of p and r2 using different statistical models. The coefficient of determination r2 ranges between (0.928125-0.996132) percent which is significant, therefore the soil around the abattoir has been adjudged to have high level of heavy metals contamination, showing the soil is polluted and did not conform to standards.

Keywords: Soil; Abattoir; Contamination; Pollutants; Heavy Metals.

Introduction

Soil, being a vital component of the environment houses most of human needs. The environment encompasses the air, water and soil, the soil like all others is also being polluted. The soil being a universal sink bears the greatest burden of environmental pollution generated by "anthropogenic" activities [1]. The lives of other valuable living organisms such as, Plants, Nematodes and other higher Animals depends on the soil for survival, the alterations of soil stability via contamination brings about imbalance in the ecosystem and nutrient for both plant and animals, in other words contamination birth pollution as a result of injection of contaminants which negatively affects people's health, comfort, property, or environment [2,3] These contaminants typically are by-products or residues from the manufacturing of anything valuable, sewage, solid waste, wastewater, accidental release, or other means as a result natural resources [4,5]. Similarly, Osemwota and Ediene further point out that soil contamination are commonly cause by unregulated sewage and other liquid waste discharged from domestic water use, contaminated industrial wastes, agricultural effluents, irrigation water drainage, urban runoff and animal husbandry from where comes the abattoir waste [6]. The physiochemical parameters of soil can be dramatically altered by operations involving abattoir waste; lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), copper (Cu), mercury (Hg), and nickel (Ni) are among the heavy metals that are most impacted. According to Dan and Ubwa , there were also reports of higher than allowed levels of trace metals in Yauri, Nigeria's soils impacted by abattoir waste [7]. Salts, chemicals, organic and inorganic materials, blood, and fat are commonly found in abattoir waste [8,9]. Cellulose-fibre makes up the majority of the undigested food in the feces of livestock animals. Other food items that are present include undigested protein, excess nitrogen from protein digestion, leftovers from fluid digestion, waste mineral matter, bacteria, mucus, and worn-out intestinal lining cells. Foreign matter, such as unclean consumed calcium, magnesium, iron, phosphorous, and sodium, is also present. Globally, a range of efforts have identified these abattoir wastes are a sources of environmental damage, and they raise the pH of the soil, which in turn causes a decline in crop growth and yield [10]. The effects of human contact with contaminated soils are found in many animal parts, such as flesh, blood, liver, kidney, innards, and hair [11].

Despite that the Swali Market abattoir is small; the waste generated by the facility is not adequately manage and treated, which affects the physiochemical parameters and heavy metal levels of the soil surrounding the abattoir in Bayelsa state and since the soil is a natural resource that takes the brunt of environmental pollutants, it is of important to prevent soil contamination in order to maintain soil fertility and boost productivity. The information gather will be used to state the conditions of soil in the abattoir and determine the level of each contaminant when compared with stated standards.

Methodology

Study area

The contaminated soils from abattoir in swail market were used in investigating the contamination rate of animal waste on soil. The abattoir within the Swali market Yenegoa, Bayelsa State, is located uphill just beside River Nun. The river is the main source of water for abattoir activities which has started within the watershed. At the abattoir site an average of 10 - 15 cows and other numbers of animals were slaughtered on daily basis, which generate waste like bones and

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cow dungs etc., and can be seen close to the river bank and on soil around the abattoir that is located in Sawli Market.

(Figure 1)

(Figure 2)

Sample collection

Six (6) soil samples were collected for six weeks at different points radially from the vicinity of the abattoir. One sample was obtained from around a well which is situated at a distance of 160m from the slaughter house identified as the control, the remaining five (5) samples were obtained within the depth of 0.5m at 2m away from the slaughter slab and 2m apart from each collection point in a circular form. The samples were collected 9am of every Monday for six successive weeks, during the dry season. The top layer of the soil was first excavated before the trowel was used to dig out the contaminated soil and placed on the rubber plate, which consequentially took place on all the 6 points of sampling as in. Samples were then dried in the air, crushed and sieved with a 2mm diameter mesh, and kept in clean polythene bags and labelled appropriately before being stored at a room temperature for laboratory analysis.

(Figure 3)

(Figure 4)

Figure 1: Location of Swali Market in Yenegoa.

Figure 2: Swali Abattoir Market.

Figure 3: Sample Collection at Abattoir.

Figure 4: Processes samples for analysis.

Determination of physicochemical parameters

The physicochemical parameters of the soil samples were obtained by applying the standard methods for analysis of soils according to (Udo E J and Ogunwale J A 1986) and (Association of official analytical chemist 1990). A crushed part of the air-dried soil sample was completely mixed with water in the ratio of 1:1 by volume and a JENWAY 3015 pH / conductivity meter was utilized to determine the pH and electrical conductivity of the soil. The physiochemical parameters included. pH, conductivity, temperature, TDS, SO4, HCO3, D.O, B.O.D, Alkanity, Acidity.

The heavy metal analysis was carried out using hydrochloric acid digestion and atomic absorption spectrometer metal ion concentration were determined (model Philips PU 9100) with a hollow cathode lamp and the Fuel rich flame (air acetylene) the chromium, cobalt, cadmium, iron, and lead at the parameters analyses.

Anaiysis of variances (anova)

Inorder to determine the differences among the mean of contaminants tested and the variation with each sample collected, relative to the amount of variation between the samples, the analysis of variances was used by means of Statistical Package for Biological and Social Sciences (SPSS) incident 20 and Python 3.6 for all physicochemical parameter tested but for Heavy metals only SPSS was used in determined the mean ± standard deviation (M±SD). Confident level of determination (P=0.05).

Results and discussion

(Table 1)

(Table 2)

(Table 3)

(Table 4)

(Table 5)

(Figure 5)

(Figure 6)

(Figure 7)

Data analysis of physicochemical parameters

The results on tables 1-5 show the laboratory analysis of soil samples collected from abattoir market in Swail, the weekly analysis revealed that pH for samples ranges from (3.2-8.5) with significant variations from each other. Although most of the pH values fells within the WHO maximum permitted standard range of (6.5-8.5) but most of the samples taken in week 1 shows a lower pH values that ranges from (3.2-4.2) which conformed to. This can result to undesirable ailments such as acidosis and this can be attributed to waste such as dung, blood, fat, intestines and urine, indices of abattoir that reduces anaerobic activities. Furthermore Idisi and Uguru, stated that the lower the pH the higher the heavy and toxic metals within any medium. The temperature of soil depends on the ratio of energy absorbed in the soil, soil temperatures ranges between -20 to 60°C, this is most important property because it shows its effect on the chemical, physical and biological processes related to growth of plants. The temperature for all the days is 29°C which is normal and remains constant for all the days and no significant difference was recorded. The electrical conductivity determines the amount of pollutant in the soil. From the tables, the

Table 1: Analysis of physicochemical parameters of Abattoir contaminated soil at Swail Market Point A.

Samples	pH	Conductivity	Temperature	TDS	SO_4	HCO_3	D.O	B. O. D	Alkalinity	Acidity
Week 1	3.8	462	29	332	343.32	1.45	5.5	0.2	75	75
Week 2	5.4	64	29	45	2403.24	0.2	5.2	0.1	125	52
Week 3	6.1	73	29	52	1030	8.05	6.3	0.2	250	75
Week 4	6.2	60	29	41	1544.94	1.3	5.4	0.2	150	755
Week 5	6.3	56	29	38	1030	1.3	5.1	0.1	125	50
Week 6	8.1	857	29	32	173	1.6	5.2	0.2	125	75

Table 2: Analysis of physicochemical parameters of Abattoir contaminated soil at Swail Market Point B.

Samples	pH	Conductivity	Temperature	TDS	SO_4	HCO_3	D.O	B. O. D	Alkalinity	Acidity
Week 1	4	464	29	336	345.32	1.47	7.5	0.4	77	77
Week 2	5.6	68	29	47	2405.24	0.4	7.2	0.3	128	54
Week 3	6.3	75	29	55	1032	8.07	8.3	0.4	252	77
Week 4	6.4	62	29	43	1546.94	1.7	7.4	0.4	152	757
Week 5	6.5	58	29	40	1032	1.5	9.1	0.3	128	52
Week 6	8.3	859	29	36	175	1.8	7.2	0.4	127	77

Table 3: Analysis of physicochemical parameters of Abattoir contaminated soil at Swail Market Point C.

Samples	pH	Conductivity	Temperature	TDS	SO_4	HCO_3	D.O	B. O. D	Alkalinity	Acidity
Week 1	3.6	460	29	330	341.32	1.43	5.3	0.1	73	73
Week 2	5.2	62	29	43	2401.24	0.1	5	0.1	123	50
Week 3	5.9	71	29	50	1032	8.03	6.1	0.1	230	71
Week 4	6	58	29	39	1542.94	1.1	5.2	0.1	130	752
Week 5	6.1	54	29	36	1032	0.9	4.9	0.1	123	48
Week 6	7.9	855	29	30	171	1.4	5	0.1	123	73

Table 4: Analysis of physicochemical parameters of Abattoir contaminated soil at Swail Market Point D.

Samples	pH	Conductivity	Temperature	TDS	SO_4	HCO_3	D.O	B. O. D	Alkalinity	Acidity
Week 1	4.2	466	29	338	347.32	1.49	7.7	0.6	79	79
Week 2	5.8	70	29	49	2407.24	0.6	7.5	0.5	132	56
Week 3	6.5	77	29	57	1034	8.09	8.5	0.6	254	79
Week 4	6.6	64	29	45	1548.94	1.9	7.6	0.6	154	759
Week 5	6.7	60	29	42	1037	1.52	9.3	0.5	130	54
Week 6	8.5	861	29	38	177	2	7.4	0.6	129	79

Table 5: Analysis of physicochemical parameters of Abattoir contaminated soil at Swail Market Point E.

Samples	pH	Conductivity	Temperature	TDS	SO_4	HCO_3	D.O	B. O. D	Alkalinity	Acidity
Week 1	3.2	440	29	310	339.32	1.41	5.1	0.1	71	71
Week 2	5	60	29	41	2399.24	0.1	4.8	0.2	121	48
Week 3	5.7	69	29	48	1030	8.01	5.9	0.1	210	69
Week 4	5.8	56	29	37	1540.94	1	5	0.2	128	750
Week 5	5.9	52	29	34	1030	0.7	4.7	0.1	121	46
Week 6	7.7	853	29	28	169	1.2	4.8	0.2	121	71

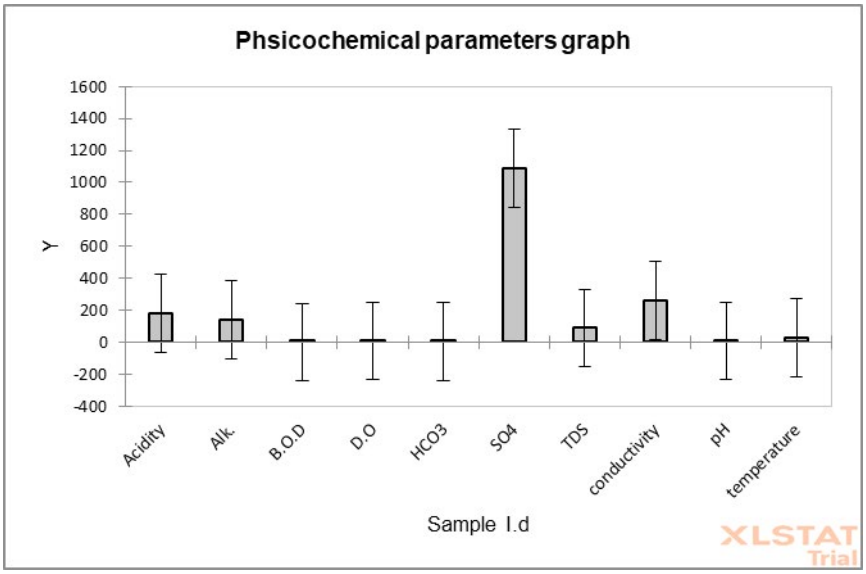

Figure 5: Analysis of Variances for Physicochemical Parameters at P-Values of 0.05 using SPSS version (20) (Mean value).

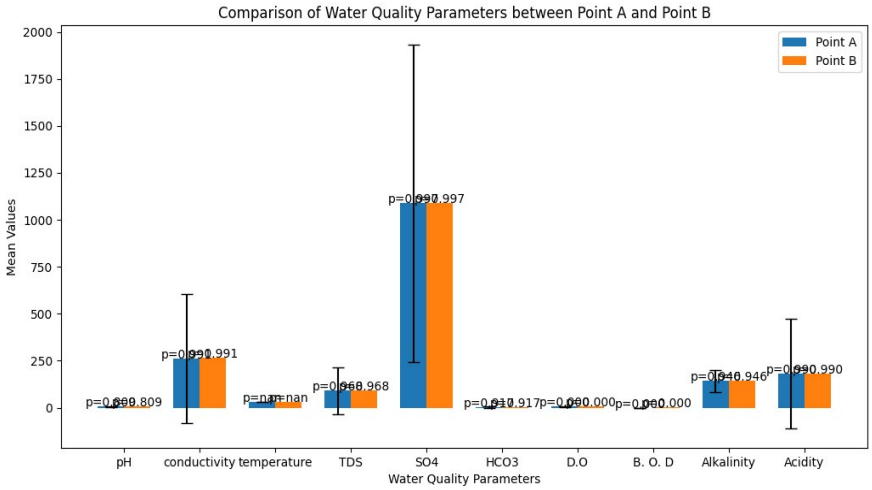

Figure 6: Analysis of Variances for Physicochemical Parameters at P-Values of 0.05 using Python 3.6 (Point A and B).

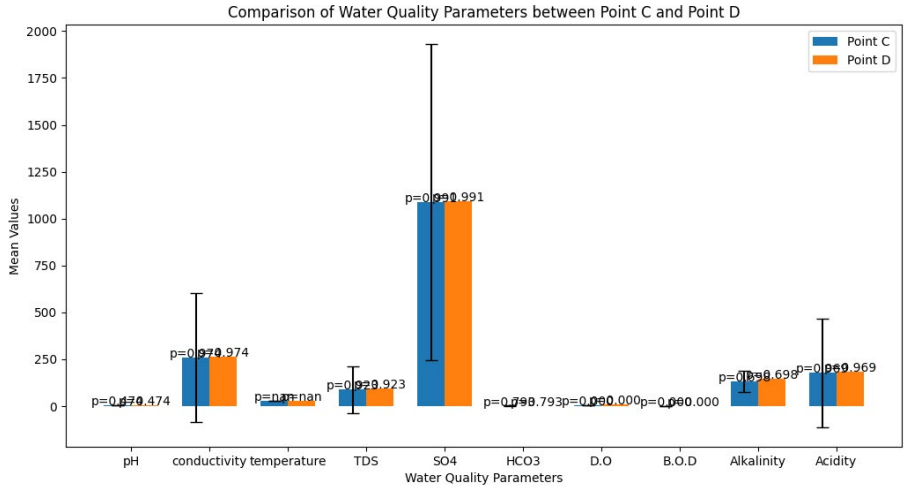

Figure 7: Analysis of Variances for Physicochemical Parameters at P-Values of 0.05 using Python 3.6 (Point C and D).

amount of electrical conductivity ranges from (52-861) μS cm^{-1}, results varied significantly from each other, although the values fell within the WHO maximum permitted standard limits 0f 1000 μS cm^{-1} . The values obtained were not in with a similar study which values ranges within (80-110) μS cm^{-1}. The results of week 1 and 6 tends to be higher when compared with others, increases could be ascribed to the buildup of wastes such as bones, hairs, flesh, and blood salts in abattoir effluents between the soil openings (Radha, 2011). The observation of high levels of electrical conductivity in abattoir soils than in the control soil could be ascribed to low cation exchange capacity (CEC) of the control soil and variations in rates at which metallic salts and organic matter complexes are formed. Total dissolved solid (TDS) ranges from (28-338) mg/kg which is within the WHO limits which is < 600. Similarly, Atuanya reported higher TDS of 330 mg/kg and above and these indicate that the higher the soluble salt content of a liquid the higher it's dissolved solute concentration. This is as a result of blood effluent which is higher in salts and cattle faeces which contained a negligible amount of salts.

The dissolved oxygen is responsible for any of the micro-organisms to survive in that environment; it's mainly the amount of oxygen that is present inside he soils that the micro-organisms living will make use of and it is supposed not to be more than 10 mg/kg. The dissolved oxygen values varied between (4.3-9.3) mg/kg from the analyzed result, all the samples recorded dissolved oxygen values ranges within the acceptable limit of WHO standard (5-10) mg/kg. which means it is well saturated. Biochemical oxygen demand is a measure of the quantity of oxygen consumed by microorganisms during the decomposition of organic matter. BOD and COD concentrations of contaminated soil are of importance as the two are major environmental concerns. On tables 1-5 the BOD values ranges from (0.1-0.6) mg/kg which is within the recommended standards of WHO and it means the soil is well saturated since the DO is high. Across tables 1-5, the values of alkalinity fell in range of (73-254) mg/kg which the total concentration values on an average more than the WHO permissible limit of 120 mg/kg indicating that the soil is alkaline. Alkalinity is a measure of the ability of water to neutralize acids and it's mainly occurs due to the presence of carbonates and bicarbonates in the soil. The result on tables 1-5 varied significantly from each other although the values did not fall within the WHO limits. The very high values of sulphate found at the vicinity of the abattoir could be attributed to the increased microbial activities due to the large deposits of animal wastes. It has been reported that although uptake in plants is not affected by additional intensification of concentration of sulphate. However, plant development could have effects on crop production especially if above the permissible limits. Bicarbonate is a product of hardness of the water that pollutes the soil its results revealed that the values of bicarbonate ranged between (0.2-8.07) mg/kg while the acidity content fells within the range of (46-757) mg/kg, the high content shows that the soil alkaline is low at the point of sampling.

Interpretation of variances analysis for contaminated soil (physicochemical parameters)

The variances analysis for physicochemical parameters using SPSS show that only acidity, alkalinity SO4 and conductivity are in the range of $P \geq 0.05$ significant level while for pH, temperature, TDS, HCO3, DO and BOD the p value are $P \leq 0.05$ significant level indicating that the null hypothesis is true and the assertion that the abattoir waste contaminate soil is true since those parameters were above the significant level at 0.09-0.90. For those values with low P-values less than 0.05 the null hypothesis is rejected and can be deduce that the contaminant data are either insufficient to confirm the contaminated level or abattoir contamination level is less of those contaminants.

Analysis of heavy metals in contaminated abattoir soil

(Table 6)

Table 6: Mean Values of heavy metals contaminated soil within abattoir in Swali market.

Sample	Pb	Cr	Mg	Co	Fe
Week 1	0.7	0.49	1.69	0.25	3.44
Week 2	0.39	0.09	1.79	0.41	3.8
Week 3	0.65	0.077	2.28	0.92	8.45
Week 4	0.73	0.066	1.79	0.44	6.59
Week 5	0.64	0.06	1.75	0.33	2.9
Week 6	0.6	0.58	1.65	0.32	2.5
Control	0.61	0.139	1.221	0.14	3.14

The above table 6 reflects the mean value of the amount of heavy metal in the analyzed contaminated soil taken from Swail at the various 5 points for a period of 6 weeks with the control values. The values of lead ranges between (0.39-0.73) mg/L which is above the WHO permissible limits of 0.015mg/l. the lead values were higher than the values from the study carried out by Igbinosa and Uwidia . The present of lead occurs in bones, blood vessels and other internal organs which when goes into the soil human body will absorbed through consumption of food, groundwater and air . The value of chromium ranged between (0.06-0.113) mg/L which is above WHO permissible limits of 0.05mg/L. The pollution of soil by chromium could be due to exposure to wastes from chromate processing amenities which are improperly thrown into open dumps. Incidentally, there is a land fill very close to the abattoir where the bones are disposed. The harmful effects of chromium to human are mostly associated with its hexavalent form. Chromium harmfulness includes liver necrosis and membrane ulcers and is responsible for dermatitis when it has contact with skin. Magnesium is a nutritional component for human beings. One of the elements which is accountable for functioning of the membrane, stimulation for transmission of nerves, construction of muscles and DNA duplication. The permissible limits of WHO is 50mg/L and from the soil it ranges between 1.22-1.79 mg/L which is lower compared to stander though it has been reported high values of magnesium could result in the hardness of water. The cobalt values ranged between 0.14-0.92mg/L, according to WHO, the acceptable limit for cobalt in soil ranges between 0.2-0.5mg/L, from table 6 at week 3 there was upshot in Co above the acceptable limit while other sampled values remain within the limit. Iron is the most abundant and most essential constituent for all plants and animals. On the one hand, at high concentration, it causes tissues damaged and some other diseases in humans. It is also responsible for anemia and neurodegenerative conditions in human being (Fuortes and Schenck., 2000). As shown in table 6, the result indicates that soil samples contained Fe in the concentration range of 2.90-8.45mg/L, iron, according to WHO standard has a limit of 0.3mg/l for consumption. The results on table 6 for iron indicate that the soil is heavily contaminated with iron.

(Figure 8)

(Table 7)

Interpretation of variances analysis for contaminated soil (heavy metals)

Table 7 and Fig. 4 above show the variances analysis for heavy metals using SPSS, the P-values ranges from 0.088178-0.778433 for

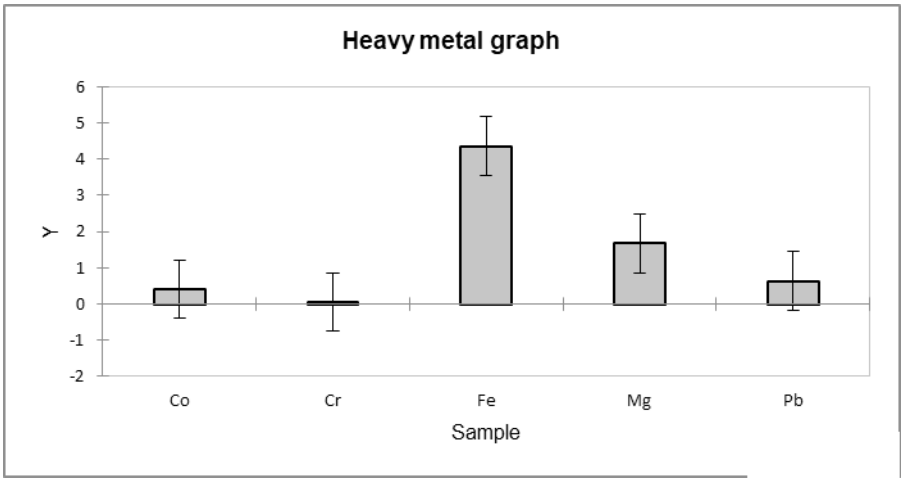

Figure 8: Analysis of Variances for heavy metals Parameters at P-Values of 0.05 using SPSS version (20) (Mean value).

Table 7: Analysis of variances for contaminated soil within abattoir in swail market with mean values and P-Values.

Elements	Mean value	P value	r^2
Pb	0.63429	0.08818	0.92813
Cr	0.13786	0.12345	0.945
Mg	1.67729	0.59878	0.95342
Co	0.40857	0.77843	0.99613
Fe	4.30571	0.2126	0.94963

all parameters consider. Since all the values are above the significant level of 0.05, it can be deduced that the contaminated soils have high level of heavy metals which is harmful to human, animal and plant. The coefficient of determination r2 ranges between (0.928125-0.996132) percent which is significant, therefore the soil around the abattoir has been adjudged to have high level of heavy metals contamination, showing the soil is polluted and did not conform to standards.

Conclusion

The ever-growing human and animal race depends directly or indirectly on the product of soil, the soil being a universal sink, it bears the greatest burden of environmental pollution generated by "anthropogenic" activities of which the abattoir is a part. Many of the existing research on abattoir waste had been on water contamination, thus this study among the few, examines the extent to which an abattoir contaminates the soil. It had been revealed that the soil in Swail abattoir market is heavily polluted with heavy metal at a significant level of P-values ranging from (0.088178-0.778433) then the hypothesis of P-values at 0.05. The coefficient of determination r2 also ranges between (0.928125-0.996132) which may have resulted from anthropogenic activities such as the use of rubber tyers to burn or stream meat as well as burning of animal skin. The tested physicochemical parameters are mostly not in conformity with the WHO standers.

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