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IMPACT OF CEMENT PRODUCTION FACTORIES ON THE PHYSICAL AND CHEMICAL CHARACTERISTICS OF SOIL WITHIN PRODUCTION AREAS IN PORT HARCOURT METROPOLIS, RIVERS STATE, NIGER DELTA, NIGERIA

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Abstract
This present study evaluated the impact of cement factories on the soil physical and chemical characteristics. Soil samples were collected from two cement factories and a control site within Port Harcourt Metropolis. The different physical and chemical parameters were analyzed using standard laboratory procedures. The mean values of the physicochemical parameters in the soil were thus: pH 7.965±0.256, electrical conductivity 286.3±5.165 µS/cm, total organic carbon 2.971±0.243%, total organic matter 4.23±0.849%, and nitrate 0.709±0.055mg/kg. Moisture content was 14.2±0.061%, clay 20.95±0.065%, silt 17.075±1.50% and sand 63.98±1.615%. The inorganic parameters; phosphate was 2.25±0.125%, ammonia 0.565±0.022mg/kg, nitrogen 1.045±0.05% and sulphate 4.583±0.0345mg/kg. The result of physico-chemical parameters from the control site were thus; pH 6.510±0.489, electrical conductivity 252.4±3.908 µS/cm, total organic carbon 2.701±0.213%, total organic matter 3.100±0.094% and nitrate was 0.631±0.065mg/kg, others were moisture content 16.61±1.025%, clay content 19.35±1.731%, silt content 18.11±1.556%, sand content 62.00±2.224%. While the inorganic parameters were phosphate 2.105±0.009%, ammonia 0.381±0.003mg/kg, nitrogen 2.201±0.105% and sulphate 3.657±0.211mg/kg. The result showed that the soil contamination due to cement dust reduced sharply with distance from the factories, this suggests that soil samples analysed in the studied areas were a bit contaminated. Therefore, it is recommended that cement factories be moved to places that are far from human environment and settlements.

Keywords: cement production, physicochemical parameters, electrical conductivity, total organic matter

Introduction

The environment is a large sinkhole that absorbs everything that is given to it and returns it in a different form that can be useful or harmful. The harmful form is known as environmental pollutants. These pollutants are chemical substances, physical substances such as heat, noise and biological substances. When released into the environment, they impair the normal stable functions of living constituents (flora and fauna) and other environmental constituents found there, as indicated by the World Health Organization (WHO, 2003).

Some pollutants stay only in the environment for a short time, while others stay long (WHO, 2003). The duration of the permanence of pollutants is generally determined by the properties of the compounds in the medium in which they are dispersed and the climatic conditions (Agbozu et al., 2017).

An environment can be air, water, soil or sediment. In most cases there is no disparity between the different media as they could flow into each other. For example, water pollutants are generally transported into the water through the soil medium, through surface runoff during the rainy season or radioactive fallout during the dry season. It can enter the ecosystem and could be deposited as sediments at the bottom of rivers, lakes or oceans (Agbozu et al., 2017).

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However, water can be contaminated by oil and other organic substances that are insoluble in water and are therefore generally attached to or adsorbed on sediments. Physico-chemical parameters such as pH, conductivity and temperature indicate soil contamination (WHO, 2003).

Cement making is an energy intensive process that involves intensive fuel consumption for clinker making, which generates emissions. In addition to fuel consumption, the calcination process is an important source of emissions such as NOx, SOx, CO2, fine dust, etc. which also have a harmful effect on the physico-chemical parameters of the soil (Shraddha & Nehal, 2014). Emissions from cement production are therefore one of the main causes of soil pollution.

The production of cement is often associated with a significant contamination of the dust particles that remain in the air and propagate on large areas due to wind and rain and accumulate in land and plants (Isikli et al., 2003; Bilen, 2010). These contaminants can cause significant pH changes and the accumulation of metals emitted in the soil affects both the composition and the physiological processes of the soil and can lead to a reduction in crop yield (McCarthy, 2003; Biyik et al., 2005).

Attention was drawn to the contamination of the soil around the cement factories due to the threat of toxicity from heavy metals in all forms of life. When cement comes into contact with the soil surface, its constituent metal undergoes various reactions that can affect soil properties. Cement dust, which is very alkaline, leads to high pH values (Mlitan et al., 2013). Metals associated with cement dust such as sodium, potassium, copper, zinc, calcium, magnesium, manganese and iron are ideal for microbial growth and metabolism, and become poisonous if their concentration exceeds a certain threshold (Asadu & Agada, 2008; Mlitan et al., 2013).

Materials and Methods

Sample Collection: Soil samples were taken from three different locations, the Dangote Onne Cement Factory, the Ibeto Rumuolumeni Cement Factory and Eagle Cement Junction Iwofe as a control location. The soil samples were collected using a stainless handheld auger at the depth of 0-20cm at the place of the cement factories and two other samples 4 meters away east and west of the first sampling point, the samples were wrapped with a cleaned, labelled aluminum foil, and then transported to the laboratory. Each of the soil samples were pooled for good representation and then divided into three parts for composite replica analysis.

Determination of Physicochemical Parameters

Determination of the pH Value: From each air-dried soil, 20g were weighed into a 150ml beaker, mixed with 30ml of distilled water, stirred with a glass rod and 30. left protocol. A HANNA pH meter (Model H 1991000) was inserted into the solution and the pH recorded as described by (Buck et al., 2002).

Electrical Conductivity: The method of Brevik et al., (2006) was used. 25g of an air-dried soil sample was placed in a 250ml beaker. Distilled water was added slowly, dropwise, and evenly over the entire surface of the soil until the soil appeared damp. A stainless steel spatula was used to form a homogeneous, dirt-saturated paste. Then the glass was covered with a petri dish. 50ml of distilled water were added and the mixture was stirred for 1 hour. 40ml of the diluted extract was placed in a 100ml beaker and the conductivity meter was used and the electrical conductivity of the soil was recorded.

Organic Carbon: The organic carbon content of the soils was determined according to the method of Todorovi et al., (2001). With this method, organic carbon is oxidized by $K_2Cr_2O_7$ in the presence of sulfuric acid (H_2SO_4). The soil samples were sieved with a 0.5mm sieve, then they were weighed twice and transferred to a 250ml Erlenmeyer flask. Exactly 10ml of 1M potassium heptaoxodichromate(VI) ($K_2Cr_2O_7$) was pipetted into each flask and gently shaken to discard the dirt, followed by the addition of 20ml of concentrated sulfuric acid. The flask was gently shaken until the bottom and reagents were completely mixed. The mixture was left to stand on a glass plate for 30 minutes. 100ml of distilled water was added, followed by the addition of 3-4 drops of ferrous indicator, after which it was titrated with a 0.5 M ferrous sulfate solution. A blank titration was also carried out.

Soil Organic Matter; (SOM): Soil Organic Matter (SOM), was analyzed according to the method of Souza et al., (2016), using the Ignition Weight Loss Procedure (LOI). The soil samples were air dried and sieved through

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a 2mm sieve. They were then oven-dried overnight at 105 °C, cooled in a desiccator and, before firing at 300, 360, 400, 500 and 550 °C. for 2h in a muffle oven (model 1200-30 L). After firing, the samples were cooled in desiccators and weighed again. The estimate of the percentage of organic matter in the soil from the loss on ignition method (SOM_{LOI}) was calculated using the following equation.
Calculations:
SOM_{LOI} = [(soil weight after combustion−oven-dry soil weight)/oven-dry soil weight] × 100.

Nitrate (NO3): The analysis of the nitrate concentration in each of the soil samples was carried out with an intelligent spectrophotometer. The soil sample solution was made from ground smaller particles. 1g of the micro-soil sample was transferred to a 100ml flask and soaked in 50ml of distilled water, the flask was closed with a stopper and shaken for 30 minutes, then filtered into another 100ml volumetric flask and the volume was made to mark with distilled water as reported by (Timothy & William, 2003). Nitrate was determined using the standard 3649 Cadmium Reduction Method.

Moisture Content: The method of Nounamo et al., (2000) was used. 1g of sieved soil sample was weighed into a dry crucible. The crucible was then placed in a convection oven at 105 °C. and dried to constant weight (for 6 hours). The sample was cooled in a desiccator and weighed again. The moisture content of the air-dried soil from the weight loss was determined as follows:

$$\text{Moisture content\%} = \frac{\text{Moist soil - Dry soil}}{\text{Moist soil}} \times 100$$

Sand / Silt / Clay: The textural quality was determined according to the method of Pratiksha et al., (2019), 50g of the sieved sample were weighed into a 250ml volumetric flask containing 2.5cm^3 of 5% sodium hexaphosphate and 400cm^3 of distilled water. Shaken for 15 minutes and the sample transferred to a 1-liter plastic beaker and diluted to the mark. A hydrometer was inserted into the suspension and the reading was taken after 40 seconds and 2 hours. The temperature of the suspension was measured after each reading.

Phosphate: The determination of phosphate described by Sicoria et al., (2005) was adopted, the phosphate was removed from the soil with a 0.5 M sodium bicarbonate ($NaHCO_3$) solution with stirring at 180 rpm for 30 min. The extractant was filtered (150mm MN 619 G filter paper), after which the phosphorus concentration of the extract was determined by optical emission spectrometry with inductively coupled plasma (ICPOES).

Ammonia: The determination of ammonia was carried out with steam using the distillation apparatus and the ammonia released by distillation was collected in a boric acid indicator solution and determined by titration with standard sulfuric acid, as reported by (Bremner & Shaw 2009).

Nitrogen: This was determined using the semi-micro Kjeldahl method by Bremner and Shaw (2009) which was modified to include water pretreatment for Kjeldahl analysis of clay soils. In this modified method used, 1g of soil sample was treated with 1ml water in a 30 ml micro Kjeldahl digestion flask and the mixture was stirred and allowed to stand for approximately 15 minutes. Then concentrated sulfuric acid (3 ml) and K_2SO_4:$CuSO_4$:Se mixture (1.1 g) were added and the mixture was digested in a micro Kjeldahl digestion flask for 5 hours. After the digestion became clear, after cooling, the digest was steam distilled with NaOH and the released ammonia was collected in a boric acid indicator solution and determined by titration with 0.01 NH_2SO_4.

Sulphate: The sulphate determination procedure of Silvia et al., (2005) was adopted; 5ml of magnesium nitrate solution was added to each of the ground and sieved samples in the crucible. These were then heated to 1800 ^{0}C on a hot plate. The heating process was allowed to continue until the colour of the sample changes from brown to yellow. Then moved to the furnace at 5000 ^{0}C for four hours followed by the addition of magnesium nitrate to prevent loss of sulphur. The content of each crucible was transferred to other evaporating dishes.10 ml of concentrated hydrochloric acid (HCl) was added to each and covered with watch glasses, then boiled in a steam bath for three minutes, on cooling, 10ml of distilled water was added to each of the sinks and their contents were filtered into 50ml volumetric flask and adjust the volumes up to the mark with distilled water. A smart spectrophotometer was used to analyze the sample for sulfate.

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Exchangeable Bases: 0.5g of air-dried soil sample (<2 mm) were weighed into a 50ml centrifuge tube. Blanks duplicates were included and quality control samples. 30.0ml of 0.1M $BaCl_2$ was added to each tube and slowly stirred for 2 hours. The supernatant was filtered with Whatman No. 41filter paper. Ca, Mg, K, and Na were analyzed with AAS as reported by (Dina & William, 2009).

Calculations

$M^+Cmol(+)\ kg^{-1} = Ccmol(+)L^{-1}$ x (0.03 L/wt.soil g)x 1000 g kg^{-1} x DF.

Where M^+ is the concentration of an adsorbed cation, $cmol(+)\ kg^{-1}$, C is the concentration of the same cation measured in the $BaCl_2$ extract ($Cmol(+)L^{-1}$), and DF is the dilution factor.

Exchangeable Acid: The method of Dina and William (2009) was used. 2.5g of soil sample were weighed into a 50ml centrifuge tube, 30ml of 1M BaCl2 solution were added and the mixture was stirred for 1h. The supernatant liquid was transferred to a 100ml volumetric flask. The procedure was repeated by adding 30ml aliquots of $BaCl_2$ solution, shaking and centrifuging. and decanted two more times, collecting all of the supernatant in the same 100ml volumetric flask, filtering the extract in a plastic bottle (Whatman No. 42 or equivalent) and storing it in a refrigerator before analysis. To obtain an exchangeable acidity, 25ml of the extract were pipetted into a 100ml beaker, 4 or 5 drops of phenolphthalein were added and titrated with 0.05M NaOH up to the first permanent pink end point. The volume of NaOH used was recorded as VA, the blank value was titrated (2 ml $BaCl_2$ solution) and recorded as VB.

Cation Exchange Capacity (CEC): The cation exchange capacity (CEC) was determined by adding the total exchangeable bases and the exchangeable acid as reported by (Dina & William, 2009).

Results and Discussion

Physicochemical Parameters of Soil Samples

The result of physicochemical parameters from the studied area is shown in Table 1

The pH from the two studied areas did not vary significantly. They were slightly alkaline ranging from 7.430±0.012 to 8.501±0.500 for Ibeto and Dangote cement factories respectively. The higher pH level in the cement factories sites than the control (6.510±0.489), may be as a result of the presence of $CaC0_3$ from the cement dust, resulting in alkalinity when it comes in contact with the soil. Alkalinity could also be due to the appreciable quantities of the exchangeable base-forming cations (Ca, Mg, K and Na) on the surface layers of the soils. The result of one-way ANOVA at $p<0.05$ showed a significant difference in the levels for the two cement factories sampled and the control. The mean value of pH in this study (7.965±0.256) is in agreement with the standard set by the World Health Organization (WHO) and Standard Organization of Nigeria (SON) given as 6.5-8.5 and also in agreement with the work of Odoh et al., (2014) in soil around Benue cement company Gboko, Benue State, with values ranging from 6.60 to 7.50. But at variance with the observation of Obianefo et al., (2017) with a mean value of 4.86±0.18 in soil from a selected waste disposal site within Port Harcourt Metropolitan city.

The electrical conductivity (EC) for the two studied area Dangote and Ibeto cement factories were 282.1±6.989µS/cm and 290.5±3.340µS/cm respectively, with a mean value of 286.3±5.165µS/cm, these values are high when compared with the control 252.4±3.908µS/cm. The result of one-way ANOVA at $p<0.05$ indicates a significant difference in the level for both cement factories sampled and the control. The high electrical conductivity values from the studied area than the control could be attributed to the high concentration of the major cations (K, Na, Mg and Ca) and salt in the soil caused by dust emission from the cement factories. However, these values were lower than the World Health Organization (WHO) maximum permissible limit of 1000µS/cm.

This result varied significantly with work by Nnaemeka et al., (2013), on forest soil in Southern Guinea savannah of Nigeria with a value of 812.0µS/cm but higher than the value of Kiran (2012), in the soil of India with a value range of 2.03 to 2.54µS/cm. The observed conductivity values from the present work are low compared to values obtained by Marcus and Edori (2020), from soil samples of leachate-contaminated dumpsite within Port Harcourt metropolis, where the value of conductivity was as high as 11,556 - 32,142µS/cm.

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This research work is in consonance with the work of Nduka and Aigberua (2018) of soil from the banks of effluent wastewater retention pits in Niger Delta Nigeria. Which values varied from 140 - 490µS/cm. The percentage (%) total organic carbon in the soils under investigation in this study were 3.081±0.435% and 2.861±0.051% for Dangote and Ibeto cement factories respectively. These values were higher than those observed at the control location 2.701±0.213% as indicated in table 1 The result of one-way ANOVA at $p<0.05$ reveals a significant difference in the levels for the two cement factories sampled and the control. The World Health Organization (WHO) acceptable limit for total organic carbon ranges from 0.5% to 3.0%, the total organic carbon in this study was therefore within the acceptable limit.

The observed total organic carbon content in this study are lower than those of Eyong and Akpa (2019) of soils derived from sandstone parent materials under selected land-use types at Agoi-Ibami in central Cross River State, Nigeria. With a value range of 4.33 to 2.10%. However, higher than the values reported by Norbert et al., (2018) for soil samples around some rivers of Cameroon with a mean value of 1.83%. The result of organic carbon is directly related to soil fertility in that it is the organic carbon present in the soil that is eventually converted to nitrate for plant uptake (Michael 2012). This suggests that the more the organic contents of soil, the more the nitrogen content of the soil, and the more fertile the soil will be.

The result of organic matter obtained in this study showed 4.330±1.043% and 4.130±0.654% for Dangote and Ibeto cement factories respectively with a mean value of 4.23±0.849. These values are higher than that of the control 3.100±0.094%. The higher organic matter in the studied area, when compared to the control, could be as a result of increased microbial activities in the soil due to cement dust and other industrial waste material in the study area. The result of one-way ANOVA at $p<0.05$ reveals a statistical difference in the levels for both cement factories sampled and the control. The recommended limit of organic matter content for soil by USEPA is 3 to 6%, the mean results obtained from this study (4.23±0.849%) showed that organic matter content is moderate and may not pose any health effect. However, the observed organic matter in this present work is higher than those of Tochukwu et al., (2017) with mean values of 2.2314±0.20359% for soil sample proximate to artisanal refining plants in Southern Nigeria but lower than those of Nduka and Aigberua (2018) which values ranged from 0.944 to 2.022% of soil from the banks of effluent wastewater retention pits in Niger Delta Nigeria.

The concentration of Nitrate ($N0_3^-$) measured in the soil sample analyzed were 0.437±0.076mg/kg and 0.981±0.034mg/kg for Dangote and Ibeto cement factories respectively with a mean value of 0.709±0.055mg/kg. These values are similar to those observed for the control site 0.631±0.065mg/kg. The levels of nitrate obtained in this study were lower than the United States Environmental Protection Agency (UNEP) maximum permissible limit of nitrate in soil 10mg/kg. The result of one-way ANOVA at $p<0.05$ reveals a significant difference between the two cement factories sampled and the control. The nitrate content observed in the present work is slightly lower than the work of Edeogu (2007), with a mean value of 2.00±0.22mg/kg in arable farmland soil in Ebonyi State Nigeria, but significantly lower than those of Nduka & Aigberua (2018), with values ranging from 40.6 to 564mg/kg in soil contaminated with wastewater from retention pits in Niger Delta Nigeria.

The total nitrate contents of soil samples from the studied area were low. The low contents could be attributed to the continuous emission of cement dust from the cement factories and the high rate of organic matter decomposition by micro-organisms as well as continuous farming in the area which promotes mineralization and absorption of nitrogen.

The moisture content of the cement factories varied from 13.9±0.046%, to 14.5±0.076% for Dangote and Ibeto cement factories respectively, with a mean value of 14.2±0.061%, these values are slightly lower than those observed for the control site 16.61±1.025%. The result of one-way ANOVA at $p<0.05$ reveals a significant difference in the levels for both cement factories sampled and the control. A similar observation has been reported by Eugen and Singh (2020) with a value ranging from 9.79% to 16.96% for the soil around cement plants in Jaintia Hills, Meghalaya India, the values also correspond with that of Edori and Iyama (2017), which range from 14.84 to 24.02% for soil from selected abattoirs in Port Harcourt. This results indicates that soil at sites near the cement plants possessed low moisture content due to the effect of cement dust.

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The soil samples in this study were dominated by sand particles of fine and medium size, the percentage level of silt varied from 15.70±1.50% to 18.45±1.50% with a mean value of 17.075±1.50%, the percentage level of sand varied from 70.07±1.780% to 57.89±1.45%, with a mean value of 63.98±1.615%, and percentage level of clay varied from 19.30±0.08% to 22.60±0.05%, with a mean value of 20.95±0.065, for Dangote and Ibeto cement factories respectively. These values are similar to those observed at the control site 18.11±1.556%, 62.00±2.334% and 19.35±1.731% for silt, sand and clay respectively.

The result of one-way ANOVA at $p<0.05$ reveals a significant difference between the two cement factories sampled and the control. The mean value observed in this study correlate with the work of Odoh et al., (2014) with a mean value of 70.7 0%, 15.90% and 13.4 0% for sand silt and clay respectively, of soil around Benue cement company Gboko and within the range of the values recorded by Buba et al., (2014) with mean values of 57.94% (sand), 21.35% (clay) and 20.71% (silt) respectively, of soil sample around Ashaka cement company Bajoga, Funakaye local government area of Gombe State, Northeastern Nigeria. The textural class of the soil was sandy-clay-loam (SCL). The percentage of sand, clay and silt are categorized as a textural class. These properties include plasticity of the soil, water retention capacity, soil productivity and soil permeability. The distribution pattern is sand >clay >silt. Particle size plays an important role in nutrient accumulation in the soil because fine-grained particles often have a greater surface to volume ratio and more organic matter.

The concentration of phosphates observed in the examined soil varied from 2.10±0.06mg/kg to 2.40±0.19mg/kg for Dangote and Ibeto cement factories respectively, with a mean value of 2.25±0.125mg/kg. The control recorded 2.105±0.009mg/kg. The result of one-way ANOVA at $p>0.05$ indicates no significant difference in the levels for the two cement factories sampled and the control. The mean level of phosphate in this study is below the limit set by Nigerian Environmental Standard and Regulations Enforcement Agency (NESREA) 5.00mg/kg. The concentration of phosphate in this work is lower than the value reported by Marcus and Edori (2020), with values ranging from 54.343 – 98.914mg/kg but higher than those of Obianefo et al., (2017) 0.04±0.01 in soil from selected waste disposal site within Port Harcourt Metropolitan city. Although the presence of phosphate as observed in the soil may be good for agricultural purposes as a required nutrient, it can also constitute a pollution source if washed to any nearby water body, which when allowed to continue will lead to a sudden rise in bacteria growth (algae bloom). The concentration of ammonia observed in this study showed 0.544±0.012mg/kg and 0.586±0.032mg/kg for Dangote and Ibeto cement factories respectively with a mean value of 0.565±0.022mg/kg. These values are higher than those observed at the control site 0.381±0.003mg/kg.

The result of one-way ANOVA at $p<0.05$ showed a significant difference in the two cement factories sampled and the control. The results of this present work are higher than those observed by Tochukwu et al., (2017) with a mean value of 0.1157mg/kg for soil samples proximate to artisanal refining plants in Southern Nigeria. But lower than those reported by Okoffo et al., (2016) with a mean value of 40.4±3.49mg/kg.The nitrogen content was observed to be 0.09±0.005% and 2.00±0.05% for Dangote and Ibeto cement factories respectively, with a mean value of 1.045±0.05%. These values are lower than that observed at the control site 2.201±0.105%.

The result of one-way ANOVA at $p<0.05$ showed a significant difference in the two cement factories sampled and the control. The mean level of nitrogen recorded in this study was similar to the standard permissible limit set by the United States Department of Agriculture (USDA) 0.2 – 1.0%. A similar observation was also reported by Ajon and Chagbe (2018) with a value ranging from 0.23 to 0.81% of soils for agriculture in Gboko Benue State. However, the mean value of this work is higher than those reported by Odoh et al., (2014) with values ranging from 0.05 to 0.09% of soil sample around Benue cement company Gboko but lower than the value reported by Okoffo et al., (2016) with a value ranging from 1.64 to 2.13%.

The percentage of nitrogen in any soil environment that occur in the form of ammonium ion (as inorganic nitrogen) is always less than 5% of the total nitrogen content in the soil.

The concentration of sulphate observed in the examined soil varied from 4.140±0.041mg/kg to 5.026±0.015mg/kg for Dangote and Ibeto cement factories respectively with a mean value of

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4.583±0.0345mg/kg. When compared to the control 3.657±0.211mg/kg, the study showed that the cement factories have an impact on the concentration of sulphate observed.

The result of one-way ANOVA at $p<0.05$ reveals a significant difference in the two cement factories sampled and the control. The concentration of sulphate in the present work is lower than the value reported by Marcus and Edori (2020) with values ranging from 20.873 to 25.306, but Nduka and Aigberua (2018) reported a similar result with values ranging from 1.4 to 5.2 mg/kg of soil from the banks of effluent wastewater retention pits in Niger Delta Nigeria. The sulphate content could be attributed to the high percentage composition of Sulphur in cement, though some of this sulphate could be of the natural source since the soil is highly contaminated with organic contaminant it is assumed that the sulphate emanates from the cement source.

Exchangeable calcium has a mean of 8.185±0.595Cmol/kg, this is within the permissible level of calcium in soil suggested by the United States Department of Agriculture (USDA) 2 – 20 Cmol/kg. The mean of other exchangeable bases of soils recorded were 3.665±0.036 Cmol/kg, 0.505±0.0185 Cmol/kg and 0.31±0.034 Cmol/kg for Mg, K and Na respectively. When compared to the control, 3.857±0.690Cmol/kg, 2.050±0.810Cmol/kg, 0.120±0.006Cmol/kg and 0.33±0.004 for Ca, Mg, K and Na respectively, the study showed a decline in exchangeable bases with distance away from the factories. The result of one-way ANOVA at $p<0.05$ reveals a significant difference in the soil of the two cement factories sampled and the control. The result observed in this present study is within the permissible limit set by the United States Department of Agriculture (USDA) 0.3-8 Cmol/kg, 0.2–2 Cmol/kg and 0.1-2 Cmol/kg for Mg, K and Na respectively. The exchangeable bases are generally moderate in the soil of the sampled locations. Calcium and Magnesium were the dominant cations. Potassium and sodium are moderate and low respectively in concentration. The exchangeable bases in the soil samples showed the following trend Ca^{2+}> Mg^{2+} K^{+}> Na^{+} similar trend was observed by Norbert et al., (2018) for soil samples around some rivers in Cameroon. Results from the present study were slightly higher than those obtained by Odoh et al., (2014) 4.55±0.31 Cmol/kg, 3.25±0.71 Cmol/kg, 0.26±0.06 Cmol/kg and 0.49±0.09 Cmol/kg for calcium, magnesium, potassium and sodium respectively but lower than those reported by Ajon and Chagbe (2018) of soil for agriculture in Gboko Benue State, Nigeria, with a value ranging from 8.45 to 17.26 Cmol/kg.

The exchangeable acidity of the soil sample from the cement factories varied from 0.95±0.06 Cmol/kg to 1.50±0.05 Cmol/kg with a mean value of 1.225±0.005 Cmol/kg. These values are higher than those observed at the control site 0.920±0.012Cmol/kg.

The result of one-way ANOVA at $p<0.05$ reveals a significant difference in the soil of the two cement factories sampled and the control. The values obtained in this present work is in agreement with the result obtained from a similar study by Odoh et al., (2014) which reported a mean value of 1.05±0.21 Cmol/kg of soil around Benue cement company Gboko Nigeria. The mean value of this study was also in agreement with the findings of Ajon and Chagbe, (2018) and ranged from 1.10 – 1.20 Cmol/kg of soils for agriculture in Gboko Benue State Nigeria. However, the mean value of this study is slightly higher than those reported by Amos-Tautua et al., (2014) of surface soils of municipal open waste dumpsite in Yenagoa Nigeria, with values ranging from 0.40±0.04 Cmol/kg to 0.96±0.06 Cmol/kg. The data indicated a low level of exchangeable acidity, which can be attributed to slight alkalinity and high base saturation of the soil contaminated by cement.

The total exchangeable base of the soil sample from the cement factories varied from 12.18±0.525 Cmol/kg to 13.15±0.421 Cmol/kg with a mean value of 12.67±0.473 Cmol/kg. These values are high when compared to those observed at the control site 6.357±1.510 Cmol/kg. The result of one-way ANOVA at $p<0.05$ reveals a significant difference in the two cement factories sampled and the control. The high base saturation of the studied soil sample may be as a result of increased Ca, Mg, K and Na by cement dust particles and other industrial decompose waste dump by the companies.

The cation exchange capacity is the amount of exchangeable cation per unit weight of dry soil that plays an important role in soil fertility. The result from this study revealed that soil from the cement factories had values that varied from 13.13±0.585 Cmol/kg to 14.65±0.471 Cmol/kg for Dangote and Ibeto cement factories

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respectively with a mean value of 13.89±0.528 Cool/kg. These values are very high when compared to the control 7.277±1.522 Cmol/kg.

The result of one-way ANOVA at $p<0.05$ indicates a significant difference in levels for the two cement factories sampled and the control. The values of the cation exchange capacity obtained for both sites are lower than the maximum tolerable limit proposed for an agricultural farm by the United States Department of Agriculture (USDA) 6 – 40 Cmol/kg. Ajon and Chagbe (2018) supported this result with values ranging from 9.65 to 18.36. However, the result was higher than those reported by Norbert et al., (2018) with a mean value ranging from 2.94 to 4.31 Cmol/kg for soil sample around some rivers of Cameroon but far lower than the values reported by Amos-Tautua et al., (2014) of surface soils of municipal open waste dumpsite in Yenagoa Nigeria which values varied from 12.98±0.31 to 91.07±0.11. The two soil samples studied had high calcium values above 4.0 Cmol/kg is regarded as a lower limit for fertile soil set by food and agricultural organization of the united nation (FAO). The exchangeable potassium varied from 0.57±0.005 Cmol/kg to 0.44±0.032 Cmol/kg in the soil sample studied these are above 0.2 Cmol/kg which is regarded as the critical limit of exchangeable potassium in soil (FAO). The implication of these is that the soil is rich in nutrients and therefore an indication of good yield potential without any input of fertilizers.

Table 1: Concentration (mean± std.dev) of physicochemical parameters of soil samples from study area.

Parameter	Dangote cement	Ibeto cement	Mean	Control
Ph	7.430±0.012	8.501±0.500	7.965±0.256	6.510±0.489
Electrical conductivity(µS/cm)	282.1±6.989	290.5±3.340	286.3±5.165	252.4±3.908
Total organic (%) carbon	3.081±0.435	2.861±0.051	2.971±0.243	2.701±0.213
Total organic matter (%)	4.330±1.043	4.130±0.654	4.23±0.849	3.100±0.094
Nitrate ($N0_3^-$) (mg/kg)	0.437±0.076	0.981±0.034	0.709±0.055	0.631±0.065
Moisture (%)	13.9±0.046	14.5±0.076	14.2±0.061	16.61±1.025
Clay content (%)	19.30±0.08	22.60±0.05	20.95±0.065	19.35±1.731
Silt (%)	15.70±1.50	18.45±1.50	17.075±1.50	18.11±1.556
Sand (%)	70.07±1.780	57.89±1.45	63.98±1.615	62.00±2.224
Phosphate (mg/kg)	2.10±0.06	2.40±0.19	2.25±0.125	2.105±0.009
Ammonia (mg/kg)	0.544±0.012	0.586±0.032	0.565±0.022	0.381±0.003
Nitrogen (%)	0.09±0.005	2.00±0.05	1.045±0.05	2.201±0.105
Sulphate (mg/kg)	4.140±0.041	5.026±0.015	4.583±0.0345	3.657±0.211
Exchangeable bases (Cmol/kg)				
Ca	8.25±0.48	8.12±0.71	8.185±0.595	3.857±0.690
Mg	2.99±0.026	4.34±0.046	3.665±0.036	2.05±0.810
K	0.57±0.005	0.44±0.032	0.505±0.0185	0.12±0.006
Na	0.37±0.014	0.25±0.054	0.31±0.034	0.33±0.004
Exchangeable Acidity (EA)	0.95±0.06	1.50±0.05	1.225±0.005	0.92±0.012
Total Exchangeable Bases (TEB)	12.18±0.525	13.15±0.421	12.67±0.473	6.357±1.51
Cation Exchange Capacity (CEC) (Cmol/kg)	13.13±0.585	14.65±0.471	13.89±0.528	7.277±1.522

Conclusion

The results showed that some of the parameters evaluated were within the normal range for soil, while some present were good due to their importance as soil nutrient except for the fact that their origin and nature may

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pose threat to plants that needed them. The soil samples analysed in the three areas were also considered moderately contaminated. Generally, there is an indication that soil quality has been compromised

References

Agbozu, I.E., Bayowa, A.V., & Oghama, O.E. (2017). Critical analysis of polycyclic aromatic hydrocarbons ring size distribution in marshy soils and sediments in Warri city and its environs, Southern Nigeria. *British Journal of Applied Science and Technology,20* (6), 1-16.

Ajon, A.T., & Chagbe, K. (2018). Assessment of cement dust emission on some physical and chemical properties of soils for agriculture in Gboko, Benue State, Nigeria. *International Journal of Agriculture, Environment and Bioresearch*, *3* (3), 255-265.

Amos-Tautua, B., Bamidele, M.W., Onigbinde, A., & Ere, D. (2014). Assessment of some heavy metals and physicochemical properties in surface soils of municipal open waste dumpsite in Yenagoa, Nigeria. *African Journal of Environmental Science and Technology*, *8* (1), 41-47.

Asadu, C.L., &Agada, C. (2008). The impact of cement kiln dust on soil physico- chemical properties at Gboko, east central Nigeria. *Nigerian Journal of Soil and Environmental Research*, *8* (3), 1595-6121.

Bilen, S., (2010). Effect of cement dust pollution on microbial properties and enzyme activities in cultivated and no-till soils. *African Journal of Microbiology Research, 4* (22), 2418-2425.

Biyik, H., Imali, A., Atalan, E., Tufenkci, S., &Ogun, E. (2005). Diversity of microfungi in soil polluted by cement factory. *Fresenius Environmental Bulletin, 14* (15), 130-137.

Bremner, J.M., & Shaw, K. (2009). Determination of ammonia and nitrate in soil. *Published online by Cambridge University Press,46* (3), 320-328.

Brevik, E.C., Fenton, T.E., & Lazari, A. (2006). Electrical conductivity as a function of soil water content and implication for soil mapping. *Precision Agriculture, 7,* 393-404.

Buba, M. W., Ibrahim, A. Q., Humphrey, M. M., Nangbes, J. G., &Nvau, J. B. (2014). Quality evaluation and physico-chemical properties of soils around a cement factory in Gombe State, Nigeria. *International Conference on Advances in Agricultural, Biological & Environmental Sciences,15* (16), 42-45.

Buck, R.P., Rondinini, S., Covington, A.K., Baucke, F.G.K., Christopher, M.A., Brett, M.F., & Camoes, M.J.T. (2002). Measurement of pH, definition, standards, a procedure (IUPAC recommendations 2002). *Pure and Applied Chemistry, 74* (11), 2163-2200.

Dina, M.S., & William, H.H. (2009) Determination of effective cation exchange capacity and exchange acidity by a one-step $BaCl_2$ method. *Soil Science Society of America Journal,3* (73), 737-743.

Edeogu, C.O., (2007). Nitrate, sulphate, phosphate and chloride status of staple food crops, soils and water as indicator of environmental base anion pollution load in Eboyi State, Nigeria. *Journal of Biological Sciences, 7* (5), 745-751.

Edori, O. S., & Iyama, W.A. (2017). Assessment of physicochemical parameters of soils from selected abattoirs in Port Harcourt, Rivers State, Nigeria. *International Journal of Environmental Analytical Chemistry, 04* (02), 1-5.

Eugene, L.R., & Singh, O.P. (2020). Effect of cement dust on soil physicochemical properties around cement plants in Jaintia Hills, Meghalaya India. *Environmental Engineering Research, 5* (3), 409-417.

Eyong, M.O., &Akpa, E.A. (2019). Physicochemical properties of soils derived from sandstone parent materials under selected land use types at Agoi-Ibami in central Cross River State, Nigeria. *World News of Natural Sciences an International Scientific Journal. 23* (2019), 1-12.

Isikli, B., Demir, T. A., Ürer, S. M., Berber, A., Akar, T., &Kalyoncu, C. (2003). Effects of chromium exposure from a cement factory. *Environmental Research,91,* 113-118.

Kiran, G. C., (2012). Studies of the physicochemical parameters of soil samples. *Advances in Applied Science Research*, *4* (6), 246-248.

Marcus, A.C. & Edori, O.S. (2020). Physicochemical composition of leachate contaminated dumpsite soil within Port Harcourt metropolis, Rivers State, Niger Delta, Nigeria. *International Journal of Green and Herbal Chemistry,9* (4), 427-436.

McCarthy, G.W., Siebielec, G., & Stuczynski, T.I. (2003). Response of soil microbiological activities to cadmium, lead, and zinc salt amendments. *Journal of Environmental Quality*, *32,* 1346-1355.

Micheal, R., (2012). Factors Affecting soil development, soil systems, the physical environment: an introduction to physical geography. *University of Wisconsin*, *Stevens Point*, Retrieved January 3rd 2012.

Mlitan, A. B., Alastal, A.I., Alsadawy, A.M., &Almedaham, A. M. (2013).toxicity of heavy metal and microbial analysis of soil sample collected from the area around zliten cement factory. *Open Journal of Air Pollution,2,* 25-28.

Nduka, J.O., &Aigberua, A.O. (2018). Heavy metals and physicochemical characteristics of soils from the banks of effluent waste water retention pits in the Niger Delta, Nigeria. *Biotechnological Research*, *4* (1), 48-53.

Nnaemeka, C. C., Esio, U. O. &Igba, J. A. (2013). Physical and chemical characteristics of forest soil in Southern Guinea savanna of Nigeria. *Agriculture, Forestry and Fisheries*, *2* (6), 229-234.

Norbert, E.K., Barbara, L.F.K., & Michael, P.H. (2008).Casarett and Doull's toxicology the basic sciences of poisons.*Mc-Graw-Hill, medical publishing division, seventh edition,* 526.

Nounamo, L., Yemifaah, M., Techienkwa, M., &Njom-Gang, R. (2000).Impact of natural fallow duration in Cameroon.*Nigeria Journal of Soil Research,3,* 52 – 57.

Obianefo, F.U., Agbagwa, I. &Tanee, F. (2017). Physicochemical characteristics of soil from selected solid waste dump sites in Port Harcourt, Rivers State, Nigeria*. Journal of Applied Science and Environmental Management,21* (6), 1153.

Odoh, R., Dauda, M.S., Oko, O.J and Lawal, U. (2014).Assessment of pysico- chemical properties of soil around Benue cement company Gboko.*Australian Journal of Education and Learning Research, 2* (04), 4-18.

Okoffo, E.D., Ofori, A., Nkoom, M., &Bosompem, O. (2016).Assessment of the physicochemical characteristics of soils in major cocoa producing areas in Dormaa West District of Ghana.*International Journal of Scientific and Technology Research,5* (2), 62-68.

Pratiksha, P.S., Ratnadeep, R.D., &Jaypalsing, N.K. (2019). Determination of soil texture distribution (clay, sand and silt) by using spectral measurement: *A Review, 6*(2), 625-629.

Shraddha, M., &Nehal, A.S. (2014).A Review on environmental and health impacts of cement manufacturing emissions.*International Journal of Geology, Agriculture and Environmental Sciences, 2* (3), 26-30.

Sicoria, F.J., Howe, P.S., Hills L.E., Reid, D.C., &Harover, D.E. (2005). Comparison of colorimetric and ICP determination of phosphorous in Mehlich soil extracts. *Communications in Soil Sciences and Plant Analysis,36,* 875-887.

Silvia, R.P.M., Nelson, M., & Elias, A.G.Z. (2005).Spectrophotometric flow-injection determinationofsulphate in soil solutions.*Talanta, 65* (5), 1313-1317.

Souza, M.D., Morais, P.A.O., Matsushige, I., & Rosa, L.A. (2016).Development of alternative methods for determining soil organic matter.*RevistaBrasileira de Ciencia de Solo,40,* 1-16.

Timothy, A.D., & William, R.H. (2003).Spectrophotometric determination of nitrate with a single reagent.*Analytical Letters*, *36* (12), 2713-2722.

Tochukwu, E.E., John, D.N., &Akachukwu, O.E. (2017).Physicochemical analysis of soils proximate to artisanal refining plants in Southern Nigeria.*British Journal of Environmental Sciences*, *5* (1), 18-26.

Todorovi, Z., Poli, P., Djordjeri, D. &Antonijeri, S. (2001). Lead distribution in water and its association with sediment constituents of the Borje Lake (Leskovae, Yugoslavia). *Journal of Serb Chemistry Society, 66* (10), 697–708.

WHO, (2003).Background document for preparation of WHO guidelines for drinking water quality. Geneva, *World Health Organization*. WHO/SDE/WSH/03.04.