

Assessment of Nutri-Chemical Concentration Levels of Wastewater from Drains Adjacent Cement and Associated Factories in Port Harcourt, Nigeria

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Abstract: This study was designed to ascertain the level of Nutri-chemical parameters from the drains adjacent the cement industry, gas tank farm and other associated activities in the Iwofe by Eagle cement road (now Dangote). This was premeditated by the industrial activities and high employment rate within the study area. Three sample points for each station made up of three composite samples were made labelled R, S, T selected based on distance from target cement factory (100m, 250m and 400m respectively) and corresponding control points of Rc, Sc and Tc respectively were used. The Nutri-chemical parameters of pH, DO, NO₃⁻, PO₄³⁻, SO₄²⁻, NH₄⁺ were determined using Horiba pH meter, Modified Azide or Winkler Method, Ultraviolet Spectrophotometric Screening Method, Stannous Chloride Method, Turbidimetric method and the Phenate method respectively (all parameters measured in mg/l except pH in units). Result showed the following ranges for pH, DO, NO₃⁻, PO₄³⁻, SO₄²⁻, NH₄⁺ were 7.14±0.01-7.22±0.01, 0.00±0.00-0.58±0.26, 4.45±0.06-4.75±0.08, 5.10±0.23-6.30±0.30, 0.40±0.12-0.90±0.20 and 2.68±0.36-3.70±0.22 respectively. The results showed that pH, nitrates and sulphates were within regulatory limits (WHO, NSDWQ, FEPA, NESREA, USEPA, SON etc) but DO, phosphate and ammonia are much above allowable limits by these regulatory agencies which poses great danger to both ground water and water usage for other beneficial uses. The one-way ANOVA and t-test showed no significant variations ($p < 0.05$). There must be deliberate attempt by relevant agencies to monitor the indiscriminate waste dump, effluents and anthropogenic inputs within this area as residential safety, hence groundwater pollution is gradual been threatened.

Keywords: Dangote, DO, drains, effluent, Nutri-chemical, pH, phosphate,

1. INTRODUCTION

According to Muhammed *et al.* (2016), most developing countries like Nigeria have challenges relating to clean water supply and adequate sanitation services, hence are prone to diseases associated with water and poor sanitation. According to Muhammed *et al.* (2016), such diseases are diarrhea, impetigo and trachoma. Very high percentages of such cases linked to diarrhoea are due to unsafe water, poor sanitary habits and hygiene globally (WHO/UNICEF, 2009). Poor water quality is considered as one of the practical proofs of poverty in developing countries. Accordingly, UN (2015) observed that improvement in drinking water supply, quality, sanitation and reducing waterborne diseases have been major components of the sustainable development goal (SDG) programmes in goal 6 formulated.

The effort to deliver safe water to the population has faced many encumbrances such as population growth, poor sanitation, and contamination of water sources with domestic wastes and industrial effluents (Alemu *et al.*, 2015; Troyer *et al.*, 2016). This showed that despite worldwide efforts of delivering safe drinking water, the transmission of waterborne diseases is still a matter of major concern. Industrial development is often associated with the generation of industrial effluents which can bring about water, sediment and soil pollution if not monitored and controlled (Fakayode, 2005).

The pH of water is the degree of acidity or alkalinity and or the negative logarithm of the water. The term "pH" refers to the measurement of hydrogen ion activity in the solution (vlab.amrita.edu. 2012). The pH is measured on a scale of 0 to 14, with lower values indicating high [H⁺] (more acidic) and

higher values indicating low $[H^+]$ ion activity (less acidic). A pH of 7 is considered as neutral. Every whole unit in pH represents a ten-fold increase or decrease in hydrogen ion concentration. According to Duressa *et al.* (2019), most natural waters possess pH values ranging from 5.0 to 8.5. Rain water has a pH value of 5.4 to 6.0, which then reacts with soils and minerals causing the reduction in $[H^+]$ and thus the water may become alkaline with a pH of 8.0-8.5 (vlab.amrita.edu., 2012). Raw wastewater generally has a pH near neutral (7.0), although it may vary between 6 and 8 based on previous studies. Low pH in water is usually caused by either low influent pH or low alkalinity water with nitrification (Duressa, *et al.*, 2019).

Chemical parameters such as pH, nitrate, and others are widely accepted as other critical water quality parameters for drinking water (Duressa *et al.*, 2019). These parameters either directly influence microbiological quality or affect disinfection efficiencies and human health (Duressa *et al.*, 2019). According to Joshi *et al.* (2009), the six main indicators of water quality includes dissolved oxygen (DO), nitrate (NO_3^-), phosphate (PO_4^{3-}) *etc.* The high demand for potable water *vis a vis* its scarcity makes it a necessity for conservation and even treatment for various beneficial uses. Other nutrient parameters of interest are ammonium (NH_4^+) and sulphates (SO_4^{2-}) (Iyama *et al.*, 2016).

This preliminary study offers good literature to the academia, government and the notary public especially those living within that vicinity of the pending and increasing concentration of nutrient and bacteriological parameters due to the influence of industrial actions, waste dump and human activities around them on their ground and surface water quality. Therefore, the need to investigate the concentrations of selected nutri-chemical parameters such as nitrates, sulphates, phosphates, ammonium pH and DO at the drains where effluent of these industries discharge their effluents was carried out.

2. MATERIALS AND METHODS

2.1 Site Selection and Location

Samples of wastewater from the drains were collected from 3 different sites along the stretch of the drainage adjoining the study stations in 3 composite sites for each station. These study stations are labelled R, S and T which were 100m, 250m and 400m respectively away from the cement and gas stations at the Iwofe- Rumuolumeni axis of Port Harcourt. Site selection was guided by the presence of certain influential anthropogenic activities. These activities range from the industrial, waste dumps and drinking bars. The geographical location was mapped using a Techno android phone installed GPS. The following locations for the composited site samples were R ($4^{\circ}47'53''N$ and $6^{\circ}56'36''E$), S($4^{\circ}48'23''N$ and $6^{\circ}56'16''E$), and T($4^{\circ}48'42''N$ and $6^{\circ}56'35''E$) with the following corresponding control stations Rc ($4^{\circ}48'6''N$ and $6^{\circ}56'36''E$), Sc ($4^{\circ}48'15''N$ and $6^{\circ}56'16''E$) and Tc ($4^{\circ}48'47''N$ and $6^{\circ}56'44''E$).

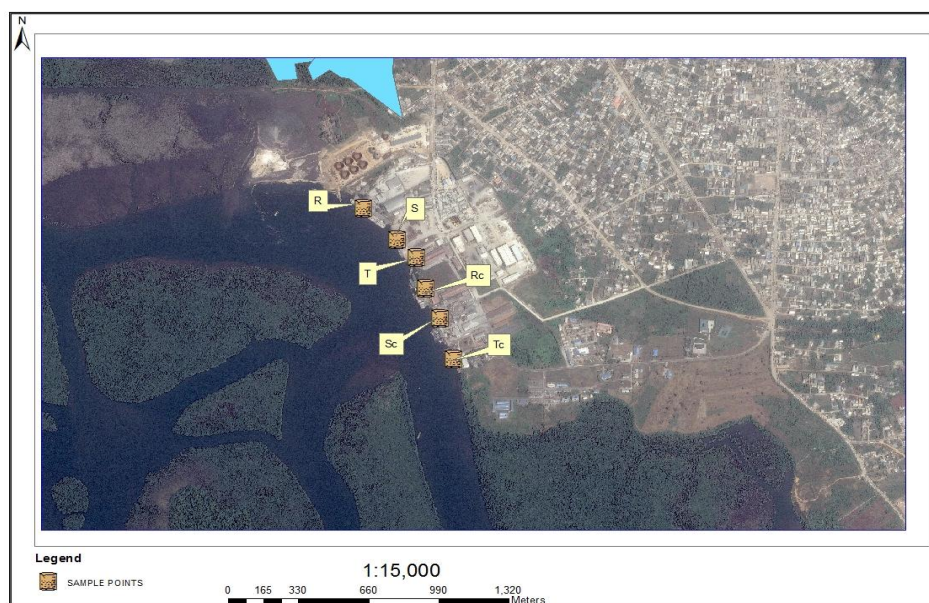


Figure1. Study Locations Showing Dangote Cement Drain Water

2.2 Sample Collection

The effluent water samples were collected using water sampler to a depth of about 20 cm below the water surface to avoid surface borne particles (which in most cases are temporal) being part of the samples. Three (3) samples were taken from each station and then composited to make up the three stations of R, S, T respectively. These stations are monitored by the control samples around each station labelled Rc, Sc and Tc respectively. The Nutri-chemical samples were placed in a 2-litre plastic container previously rinsed with the sample purported to be collected and sealed correctly.

The water samples collected were then stored in ice-packed coolers and preserved in accordance with part VII Section D of the DPR Environmental Guidelines and Standards. Laboratory analysis of the nutri-chemical parameters were done in compliance to standard practice by DPR Environmental Guidelines and Standards (DPR/EGASPIN, 2002). Laboratory methodologies for wastewater were adopted from Standard Methods for the Examination of Water and Wastewater, 19th Edition, 1995.

2.2.1 Dissolved Oxygen (DO) Determination

DO was analyzed using the Winkler Methods (APHA, 1998). Fill a 70 ml BOD bottle with 0.5 ml of manganous sulphate solution (Winkler I) and 0.5ml alkali-iodide-azide reagent (Winkler II). This was stoppered to exclude air bubbles and mixed by several inversions. This is followed by the addition of 0.5ml concentrated H₂SO₄ after about 5-10 minutes, re-stoppered and mixed for complete dissolution of precipitate. Finally, observing all necessary quality control measures and preservation, the fixed samples were moved to the Institute of Pollution Studies (IPS) of the Rivers State University, Port Harcourt, Nigeria laboratory for further analytical processes.

2.2.2 Nitrate (NO₃⁻)

Nitrate was measured by the Ultraviolet (UV) Spectrophotometric Screening Method. A 1.0 ml HCl solution was added to 50ml clear sample and properly mixed. The nitrate concentration was obtained from the standard curve from absorbance measurements at a wavelength of 220nm. The limit of detection was 0.05mg/l.

2.2.3 Phosphate (PO₄³⁻) Determination

This is determined by the Stannous Chloride Method (APHA, 1992). To 50ml sample, 2.0ml ammonium molybdate reagent and 0.2ml stannous chloride reagent and mixed properly. After adding the stannous chloride (after about 10-12 minutes), the absorption of the treated sample is read off on spectronic 21D at 690nm. Finally, phosphate level is obtained by reading off the absorption level from standard curve using 0.05mg/l detection limit.

2.2.4 Sulphate Determination

Sulphate was determined using the turbidimetric method (APHA, 1995). To a 50ml sample or portion diluted to 50ml contained in a conical flask, 2.5 ml of conditioning reagent (a mixture of 50ml glycerol with a solution of 30ml concentrated HCl, 300ml distilled water, 100ml 95% ethanol and 75g sodium chloride) and a quarter spatula full barium chloride (BaCl₂). The mixture was swirled for a minute and the barium sulphate (BaSO₄) turbidity read off at the 5th minute on the Spectronic 21D at 420nm against water. Sulphate level was read from a calibration curve prepared for sulphate standards treated the same way as the samples using 1.0mg/l detection limit.

2.2.5 Ammonia Determination

Ammonia can be determined by the Phenate method. To a 25ml sample in 50ml Erlenmeyer flask, the following were added; 1ml sodium nitroprusside solution, 2.5 oxidizing solution and 1ml phenol solution. The samples were covered for 1 hour to allow for the colour development at an absorbance of 630nm and the concentration calculated by reference to the standard curve at a detection limit of <0.02mg/l.

2.4 Summary of Analytical Technique

The following analytical techniques and guidelines were employed for the analysis of the parameters under study. All quality control measures were made and standard methods for examination of water and wastewater was also adopted. Table 1 shows the summary of analytical techniques employed for Nutri-chemical.

Table1. Summary of Analytical Techniques for the Nutri-chemical Parameters

Parameters	Analytical Methods/Techniques	Wavelengths of Operation
pH	Horiba water Checker (model U-10)	-
DO (Mg/L)	Winkler Method (APHA, 1998)	-
NO ₃ ⁻ (mg/L)	Ultraviolet Spectrophotometric Screening Method	220nm
PO ₄ ³⁻ (mg/L)	Stannous Chloride Method (APHA, 1995)	690nm
SO ₄ ²⁻ (mg/L)	Turbidometric method (APHA, 1995)	420nm
NH ₄ ⁺ (mg/L)	Phenate method	630nm

2.5 Statistical Analysis

Data obtained from the laboratory analysis of the water samples were analyzed using descriptive and inferential statistical techniques, notably tables, mean and one-way analysis of variance (ANOVA).

3. RESULTS AND DISCUSSIONS

The results of the nutri-chemical parameters in April, May and June for the different stations of R, S and T are shown in Tables 2, 3 and 4 while the temporal and spatial mean concentrations for the nutri-chemical parameters are in Tables 5 and 6 respectively. The concentrations of ammonium (NH₄⁺) for the study stations of R, S, T in the months of April, May and June were 3.50±0.20, 3.45±0.16, 2.70±0.37 with control of 0.90; 3.40±0.15, 3.50±0.22, 2.68±0.36 and control of 1.00 and 3.48±0.06, 3.70±0.22, 3.00±0.28 and control of 1.20 respectively. The ranges for the Nutri-chemical parameters are shown in Table 7.

The concentrations of pH (units) in the study stations of R, S and T for the months of April, May and June respectively were 7.18±0.01, 7.15±0.01, 7.14±0.00 while the control station was 7.15; 7.17±0.01, 7.16±0.01, 7.16±0.00 and control of 7.15 and 7.22±0.01, 7.22±0.01, 7.20±0.00 and control of 7.14. The pH of the drain water was within the range established by regulatory agencies of 6.5-9 (NSDWQ, 2008; WHO, 2004; NESREA, 2011). This agrees with the range obtained in earlier research (Dimowo, 2013; Tesfamariam & Younis, 2016; Akoto *et al.* 2008; FEPA, 1991). The range of pH (7.14-7.22) shows that the surface water drains was alkaline as aquatic organisms are heavily affected by pH, most of their metabolic activities are pH dependent (Fakayode, 2005). Various researches have shown the impact of industrial activities on the physico-chemical parameters of rivers and streams (Adekunle & Eniola, 2008; Ogedengbe & Akinbile, 2004; Fakayode, 2005; Akoto *et al.*, 2008). This alkaline nature of the drain water may be linked to certain alkaline inducing substances and soil content. The relatively small variation between the pH values from those of the control station is an indication of little or no impact of anthropogenic manipulations. The mean pH levels of all the samples were found to be well below and outside the tolerable range as specified by the Environmental Conservation Regulations (ECR) and met the National Drinking Water Quality Standards (NDWQS) for rural surface water supply systems (NDWQS, 2008). The major sources of pollution were observed to be effluents from the industries and dump sites within and around the Creek catchment (Ewa *et al.*, 2011). The highest level of pH was found down the junction by Iwofe road by June. This may be attributed to the higher rate of serial dilution from precipitation which increases the pH impacting high alkalinity to the drain water. Stream flow direction is critical to protecting water quality and preserving aquatic habitat (Ugbaja & Ephraim, 2019). The least value of pH values were found in the months of April and May which may also emanate from concentration factor due to draught. The spatial increase was also observed in stations R and S due to the impacts of minor industrial and human inputs upstream of the road.

The DO (mg/l) for stations R, S, T in April, May and June were 0.05±0.01, 0.04±0.01, 0.01±0.01 and control of 0.50; 0.50±0.21; 0.05±0.11, 0.58±0.26 and control of 1.20; 0.01±0.00, 0.01±0.00; 0.00±0.00 and control of 8.50 respectively. The DO (mg/l) concentration is comparatively very low and shows that the water body lacks dissolved oxygen and below the permissible limits (WHO, 2004; NSDWQ, 2008; GoN, 2012). Dissolved Oxygen is a measure of the amount of oxygen dissolved in the given water or water body (Iyama, Brown & Okpara, 2018). According to Iyama and Edori (2014), DO is essential in the determination of water quality index of a creek water body such as that of the Imonite, Ndoni in Nigeria. These concentrations were far below those of similar research by Ugbaja and Ephraim (2019) whose values were even above WHO (2004) permissible limits. These relatively low values may reflect early indication of undesirable conditions in the physical, chemical and biochemical factors

within the water bodies (Ugbaja & Ephraim (2019). This was relatively lower than those recorded by Ewa *et al.* (2011) and on the impact of industrial activities on water quality of Omoku Creek, Nigeria. The values were also lower than those earlier observed by Dimowo (2013) on the assessment of some physico-chemical parameters of River Ogun Abeokuta, Ogun State, Nigeria. The water from these sources may also be contaminated with domestic and municipal, agricultural, surface run-off, industrial wastes and accidental spillage and which is likely to cause water related diseases (Ojekunle, 2000; Walsh, 1980). Definitely, Ewa *et al.* (2011) posited that dissolved oxygen (DO) is a measure of the degree of pollution by organic matter, the destruction of organic substances as well as the self-purification capacity of the water body. According to Iyama *et al.* (2018), the concentration of DO is a function of the biological activities prevalent in the body of water, but the main sources of DO in water are diffusion of oxygen from surrounding air, photosynthetic activities and aeration of water resulting from tumbled over falls and rapids. High or low pH values in rivers affect aquatic life and alter the toxicity of other pollutant in one form or the other (Morrison *et al.*, 2001). Similarly, DO in liquid provide a source of oxygen needed for the oxidation of organic matter when the concentration whose deficiency causes the water body to become dead or devoid of aquatic life (Chukwu, 2008).

Nitrate (NO_3^- in mg/l) concentrations for the study stations R, S, T in April, May and June were 4.50 ± 0.09 , 4.65 ± 0.01 , 4.75 ± 0.08 and control of 2.35; 4.45 ± 0.06 ; 4.50 ± 0.02 , 4.65 ± 0.08 and control of 2.30; and 4.50 ± 0.01 , 4.52 ± 0.00 , 4.55 ± 0.02 with control of 2.50 respectively. The amount of nitrate (NO_3^-) in the study ranged between 4.45 to 4.75 mg/l but was found highest at April but least in June. This was similar to the range of 2.2-6.5mg/l recorded earlier (Duressa *et al.*, 2019). The observed values of nitrate in the present work were above the range earlier recorded by Raj and Sevarkodiyone (2018) in a studied pond whose range was 0-0.40mg/l but fall within the range of 2.1-12.8mg/l values reported by Simpi *et al.* (2011) in Hosahalli Tank, Karnataka. This also be linked to the impact of dilution effect of rains higher in June but lower by March and followed by May. According to Iyama *et al.* (2018), nitrate is the most stable form of nitrogen and also the commonest form in natural and fresh domestic wastewater and could also be found in the effluent of nitrifying biological treatment plants (occurs up to 30mg) nitrate as nitrogen per litre. In most cases, the contamination resulting from the presence of nitrate and phosphate leads to eutrophication hence reduction in water quality (Iyama *et al.* (2018). The values so obtained were all below the permissible limits by WHO (45mg/l) and NSDWQ (10mg/l) for surface water (WHO, 2004; NSDWQ, 2008). Nitrates are forms of nitrogen found in several different forms in terrestrial and aquatic ecosystems. The main forms of nitrogen are ammonia (NH_3), nitrates (NO_3^-), and nitrites (NO_2^-) (USEPA, 1986). These concentrations were higher than those recorded by Dimowo (2013) in assessment of some physico-chemical parameters of River Ogun, Abeokuta, Ogun State, Nigeria. The variation in nitrate content of the wastewater was within similar range for earlier studies (Ugbaja & Ephraim (2019). According to Ugbaja & Ephraim (2019), most of the dry season samples had elevated nitrate levels that exceeded the 10 mg/l permissible limits of the Nigerian standard for drinking water quality which is similar to the observed trend though not as high as this (NSDWQ, 2008), hence the water is polluted by nitrate. Nitrate is essential for growth hence high concentration of nitrate indicates eutrophication which impairs water quality (Ugbaja & Ephraim, 2019). Though, nitrate itself is not a direct toxicant to human but constitutes a health hazard through conversion to nitrite, which reacts with blood haemoglobin to cause methemoglobinemia in infants less than 6 months old (Ugbaja & Ephraim, 2019). The source of nitrate in most surface water is associated with geological, agricultural and anthropogenic performers. However, in the absence of nitrogen-bearing rocks, the enrichment of nitrate in the study area can be attributed to fertilizer usage, seasonal influence of biomass burning, harmattan dust during the dry season and leachates from human and animal sewages, pit latrines and refuse dump located close to streams (Ugbaja & Ephraim, 2019).

Similarly, sulphate (SO_4^{2-}) concentrations in the study stations of R, S, T for the months of April, May and June were 0.45 ± 0.12 , 0.50 ± 0.08 , 0.90 ± 0.20 and control of 0.45; 0.40 ± 0.12 , 0.50 ± 0.05 , 0.80 ± 0.16 and control of 0.40; and 0.55 ± 0.04 , 0.60 ± 0.00 , 0.65 ± 0.04 and control of 0.50 respectively. The concentration of sulphate (SO_4^{2-} in mg/l) in the study stations showed a range of 0.45-0.90 (April), 0.40-0.80 (May) and 0.55-0.65 (June) but the overall range was 0.40-0.90 mg/l. These concentrations were really below the permissible limits as recommended by NAFDAC, SON, FEPA, NSDW, WHO, EU and USEPA (NSDWQ, 2008; WHO, 2004). These values were relatively higher than those earlier observed as this amount may likely emanate from waters coming from agricultural fertilizer runoff entering surface waters by rain drainage (Ugbaja & Ephraim, 2019). Natural water frequently contains

impurities that come from natural or anthropogenic sources (Adeyeye, 1994; Asaolu *et al.*, 1997). High sulphate levels in waters may be due to agricultural and anthropogenic activities (Ephraim & Ajayi, 2015). Other factors to elevated levels of Sulphate in surface water are types of minerals occurring in the watershed, acid rain and others (Ugbaja & Ephraim, 2019). Sulphate levels may also be attributed to the use of barium sulphate as additive in various plastic products dumped around the abandoned waste site (Ellila, 2011). According to Iyama *et al.* (2018), the reduction of sulphates to sulphides (particularly H_2S) causes odour and corrosion problems and also scaling in industrial water supplies and can have laxative effect on man. Sulphates may also be produced through leachates from human and animal sewages, pit latrines and refuse dump located close to streams or water bodies (Ugbaja & Ephraim, 2019).

Phosphate (PO_4^{3-}) concentration for the months of April, May, June and the study stations of R, S, T were 6.20 ± 0.49 , 5.15 ± 0.25 , 5.16 ± 0.24 with control of 5.50; 6.00 ± 0.41 , 5.10 ± 0.23 , 5.15 ± 0.19 and control of 1.00; and 6.30 ± 0.30 , 5.50 ± 0.26 , 5.80 ± 0.05 with control of 1.20 respectively. The concentration of phosphate (PO_4^{3-} in mg/l) in the study stations showed a range of 5.15-6.20 (April), 5.10-6.00 (May) and 5.50-6.30 (June) while the overall range was 5.10-6.30 mg/l. These values are found to be slightly above the WHO limit of 5mg/l and 3.5 limit for NESREA (National Environmental Standards and Regulations Enforcement Agency, Nigeria) and extremely below the NSDWQ limit of 100mg/l though the relatively high concentration of phosphate above WHO (2004) limit can be attributed to the increased use of phosphates in the form of fertilizers for enhanced plant growth and its use in meat processing and poultry production industries (Chien, Prochnow & Cantarella, 2009; Bach Son Long, Gál & Buňka, 2011). This concentration of phosphate is higher than those observed by Duressa, *et al.*, (2019) in another water body earlier (range, 0.65-1.0mg/l). Total phosphate-phosphorus value exceeding 0.1mg/l can lead to accelerated growth, eutrophication, problems and natural water degradation (Water Resource Centre WRC, 2014). This could lead to problems if the effluents were to be released into the water bodies (Ugbaja & Ephraim, 2019). High concentrations of phosphate are often responsible for eutrophic conditions in water bodies (Ugbaja & Ephraim, 2019). Phosphates enter waterways from human and animal waste, phosphorus rich bedrock, laundry, cleaning, industrial effluents, and fertilizer runoff and become detrimental when they over fertilize aquatic plants and cause stepped up eutrophication (WRC, 2014). Too much phosphate can lead to death of aquatic organisms especially the presence of orthophosphate (WRC, 2014). Phosphates are not toxic to people or animals unless they are present in very high levels though digestive problems could occur from extremely high levels of phosphate (WRC, 2014). Conversely, these values were also higher than those obtained by Raj & Sevarkodiyaone (2018) in a studied pond (0.36 to 2.86mg/L).

The concentrations of ammonium (NH_4^+ , mg/l) for the study stations of R, S, T in the months of April, May and June were 3.50 ± 0.20 , 3.45 ± 0.16 , 2.70 ± 0.37 with control of 0.90; 3.40 ± 0.15 , 3.50 ± 0.22 , 2.68 ± 0.36 and control of 1.00; and 3.48 ± 0.06 , 3.70 ± 0.22 , 3.00 ± 0.28 and control of 1.20 respectively. The range of NH_4^+ in the study station was 2.68-3.70mg/l. These values were higher than both NSDWQ and WHO permissible limits of 1.0mg/l and 0.5 mg/l respectively. The values observed in the water from the drains were relatively higher than those earlier reported by Ugbaja and Ephraim (2019) on the physicochemical and bacteriological parameters of surface water quality in part of Oban Massif, Nigeria. According to earlier works by Ogedengbe and Akinbile (2004), industrial waste remains the most common source of water pollution in the presentday Nigeria. Ammonia and nitrite are more toxic than nitrate in the aquatic environment (Dimowo, 2013). Wastewater contains pollutants in the form of carbon (cBOD) and ammonia nitrogen (NH_3), hence anything which limits the effectiveness of the nitrifying bacteria to convert ammonia to nitrate will cause the aeration tank effluent ammonia concentrations to increase, an indication of loss of control. Nitrification is a two-step process for the removal of ammonia from wastewater using two different types of autotrophic bacteria which oxidizes ammonia to nitrite (nitrosomonas) and then oxidize nitrite to nitrate (nitrobacter). Ammonia is toxic to both fish and invertebrates and ammonia in water is an indication of low chlorine levels. The USEPA recommends a limit of 0.02 mg/l for NH_3 in freshwater or marine environments. Research has shown that total ammonia levels, at this limit, can range from 160 mg/l at pH 6 and temperature of 5^oC degrees C to 0.06 mg/l at pH 9 and temperature of 25^oC. Domestic sewage typically contains 20 to 40 mg/l (ppm) of ammonia nitrogen (NH_4-N), hence at small concentrations; ammonia can cause significant deterioration to the flora and fauna in the body of water receiving it. Analysis of physicochemical parameters of the various wastewater categories yielded range of 0.00-0.72 mg/l of NH_3-N in

wastewater of a fertilizer-factory-waste discharge equalization basin which was far lower than the results of this study (Uba, 1995). According to Habermayer and Sanchez (2005), nitrification process can occur at DO levels as low as 1 mg/l as aeration can reduce ammonia levels through physical means. Ammonia levels in wastewater can be reduced through the process of desorption (Patoczka & Wilson, 1984). Industries turn out wastes which are peculiar in terms of type, volume and frequency (Adekunle, 2008). The colour and odour of the wastewater samples were turbid and objectionable in consonance with those earlier observed for Urinjikulam pond water (Raj & Sevarkodiyone, 2018). Pollution of water is measured by assessing the physiochemical parameters of water (Wankhade, Manwar, & Malu, 2012).

Table2. Nutri-chemistry of Drain Wastewater (April, 2020)

Parameters	Stations			
	R	S	T	Control
pH	7.18±0.01	7.15±0.01	7.14±0.00	7.15
DO (mg/L)	0.05±0.01	0.04±0.01	0.01±0.01	0.50
NO ₃ ⁻ (mg/L)	4.50±0.09	4.65±0.01	4.75±0.08	2.35
PO ₄ ³⁻ (mg/L)	6.20±0.49	5.15±0.25	5.16±0.24	5.50
SO ₄ ²⁻ (mg/L)	0.45±0.12	0.50±0.08	0.90±0.20	0.45
NH ₄ ⁺ (mg/L)	3.50±0.20	3.45±0.16	2.70±0.37	0.90

Table3. Nutri-chemistry of Drain Wastewater (May, 2020)

Parameters	Stations			
	R	S	T	Control
pH	7.17±0.01	7.16±0.01	7.16±0.00	7.15
DO (mg/L)	0.50±0.21	0.05±0.11	0.58±0.26	1.20
NO ₃ ⁻ (mg/L)	4.45±0.06	4.50±0.02	4.65±0.08	2.30
PO ₄ ³⁻ (mg/L)	6.00±0.41	5.10±0.23	5.15±0.19	1.00
SO ₄ ²⁻ (mg/L)	0.40±0.12	0.50±0.05	0.80±0.16	0.40
NH ₄ ⁺ (mg/L)	3.40±0.15	3.50±0.22	2.68±0.36	1.00

Table4. Nutri-chemistry of Drain Wastewater (June, 2020)

Parameters	Stations			
	R	S	T	Control
pH	7.22±0.01	7.22±0.01	7.20±0.00	7.14
DO (mg/L)	0.01±0.00	0.01±0.00	0.00±0.00	8.50
NO ₃ ⁻ (mg/L)	4.50±0.01	4.52±0.00	4.55±0.02	2.50
PO ₄ ³⁻ (mg/L)	6.30±0.30	5.50±0.26	5.80±0.05	1.20
SO ₄ ²⁻ (mg/L)	0.55±0.04	0.60±0.00	0.65±0.04	0.50
NH ₄ ⁺ (mg/L)	3.48±0.06	3.70±0.22	3.00±0.28	1.20

Table5. Temporal mean concentration for Nutri-chemical parameters in drain Wastewater

Parameters	Stations			
	R	S	T	Control
pH	7.16±0.01	7.16±0.01	7.21±0.02	7.15
DO (mg/L)	0.03±0.04	0.21±0.09	0.01±0.05	0.50
NO ₃ ⁻ (mg/L)	4.63±0.05	4.53±0.02	4.52±0.03	2.35
PO ₄ ³⁻ (mg/L)	5.50±0.07	5.42±0.13	5.87±0.19	1.05
SO ₄ ²⁻ (mg/L)	0.62±0.01	0.57±0.02	0.60±0.00	0.45
NH ₄ ⁺ (mg/L)	3.22±0.04	3.19±0.06	3.39±0.08	0.90

Table6. Spatial mean concentration for Nutri-chemical parameters in drain Wastewater

Parameters	Stations			
	R	S	T	Control
pH	7.19±0.01	7.18±0.00	7.17±0.01	7.15
DO (mg/L)	0.19±0.04	0.03±0.08	0.20±0.04	3.40
NO ₃ ⁻ (mg/L)	4.48±0.06	4.56±0.00	4.65±0.06	2.38
PO ₄ ³⁻ (mg/L)	6.17±0.40	5.25±0.25	5.37±0.16	1.08
SO ₄ ²⁻ (mg/L)	0.47±0.08	0.53±0.04	0.78±0.13	0.45
NH ₄ ⁺ (mg/L)	3.46±0.16	3.45±0.15	2.79±0.31	1.03

Table7. Ranges for the Nutri-chemical Parameters for Wastewater Drains

Parameters	Stations			
	April	May	June	Control
pH	7.16-7.18	7.16-7.17	7.20-7.22	7.14-7.15
DO (mg/L)	0.01-0.05	0.05-0.58	0.00-0.58	0.05-8.50
NO ₃ ⁻ (mg/L)	4.50-4.75	4.45-4.65	4.50-4.55	2.30-2.50
PO ₄ ³⁻ (mg/L)	5.15-6.20	5.10-6.00	5.50-6.30	1.00-1.20
SO ₄ ²⁻ (mg/L)	0.45-0.90	0.40-0.80	0.55-0.65	0.40-0.50
NH ₄ ⁺ (mg/L)	2.70-3.50	2.68-3.50	3.0-3.70	3.19-3.39

Table8. Value/Concentration ranges of Nutri-chemical Parameters in Drains and Standard Limits

Parameters	Present Work	NSDWQ	WHO	USEPA
pH	7.14-7.22	6.5-9.0	6.5-8.5	6.5-8.5
DO (mg/L)	0.00-8.50	10	5-10	5.5-6.5
NO ₃ ⁻ (mg/L)	2.30-4.75	50	45	10
PO ₄ ³⁻ (mg/L)	1.00-6.30	0.5	0.5	0.05-0.1
SO ₄ ²⁻ (mg/L)	0.40-0.09	100	250-500	250
NH ₄ ⁺ (mg/L)	2.68-3.70	1.0	0.5	0.02

The ANOVA result indicates that the levels of physico-chemical parameters in the three sampling points do not vary significantly with FEPA's and WHO's permissible limits for surface water (F = 2.84, p<0.05). Similarly, from the one way ANOVA, no significant differences at both temporal (f-ratio of 0.0017, p-value of 0.9983) and spatial dimensions (f-ratio of 0.0083 and p-value of 0.9917) for the nutri-chemical parameters at p<.05 were recorded while t-test for comparing the mean concentration from the control also showed no significant differences (p<.05).

4. CONCLUSION

The study for the determination of Nutri-chemical levels of the wastewater drains from vicinities around cement and associated factories in Port Harcourt, Nigeria revealed infinitesimal impact due to their direct operations but rather more impact from human activities around. The result showed that pH, nitrates and sulphates were within regulatory limits (WHO, NSDWQ, FEPA, NESREA, USEPA, SON etc) but DO, phosphate and ammonia are much above allowable limits by these regulatory agencies which poses great danger to both ground water and water usage for other beneficial uses. It behooves on government to re-enforce her environmental monitoring and regulatory bodies to ensure compliance because of the gradual increase in the studied parameters.

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