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Assessing the impact of Abattoir Effluent discharge on the Physicochemical and Microbial Water quality of Nwamgboko Stream, Amikwo Awka, Anambra State

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Abstract

This research work aimed at assessing the impact of abattoir effluent discharge on the physicochemical and microbial water quality of Nwamgboko stream, Amikwo Awka, Anambra State. Water samples were collected from the stream at four (4) different locations namely: the upstream point (control sample) (CP1), point of discharge of effluent (CP2) and downstream points (CP3) and (CP4). The upstream point was 10 meters from the effluent discharge point and the downstream points were successively 10 meters from each point and with reference to the point of discharge of abattoir effluent into the stream. In this research, the physicochemical and microbial water quality of the stream were analyzed. The physicochemical parameters analyzed were Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Turbidity, Temperature, pH, Nitrate (NO3), Phosphate (PO4) and Ammonium (NH4). While the microbial parameters analyzed were E.coli, microbial count (TCC), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Dissolved Oxygen (DO). The results revealed that the mean concentrations of Total Dissolved Solids (TDS), pH and Nitrate (NO3) in water samples were 82.5 mg/l, 7.2 and 10.0 mg/l respectively which were within the maximum allowable limit set by (NSDWQ 2007) and (WHO 2008) while the mean concentrations of Total Suspended Solids (TSS), Turbidity, Temperature, Phosphate (PO4) and Ammonium (NH4) were 615.25 mg/l, 19.0 NTU, 30.8 , 1.53 mg/l and 3.71 mg/l respectively and were above the maximum allowable limit set by NSDWQ (2007) and WHO (2008). It was also showed that the mean concentration of E.coli, Total coliform count (TCC), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Dissolved Oxygen (DO) in water samples were 10,776.25 cfu/ml, 174 cfu/ml, 362 mg/l, 875 mg/l and 2.73 mg/l respectively which were above the maximum allowable limit recommended by (NSDWQ 2007) and (WHO 2008). These tests results showed that water samples collected at the downstream of the abattoir discharge point of the stream possessed higher microbial contamination owing to the injection of faecal and organic materials from the slaughter house and therefore need substantial treatment before use for domestic, industrial and other uses.

KEYWORDS: Abattoir, Effluent, Impact, Physicochemical, Microbial, DischargeAbattoir, Effluent, Impact, Physicochemical, Microbial, Discharge

1. INTRODUCTION

Water is an essential resource for human survival and most of the water consumed are surface water. The discharge of untreated effluent in these surfaces water bodies such as streams, rivers, lakes, and oceans, result in the pollution of such water bodies. This pollution elevates the level of nutrients such as Nitrogen and Phosphorus in the water bodies thereby accelerating the growth of Oxygen-depleting microbes which destroys the ecosystem and results in Eutrophication. A global study by the World Health Organization (WHO 2008) estimates that using polluted water either for bathing, drinking etc., causes about 250 million cases of gastro enteric, upper respiratory disease, typhoid, cholera and other water borne diseases annually (Nwankwo et al, 2022).

Nwamgboko stream is an important supporting part of the ecosystem in Amikwo Awka, providing water for irrigation and other domestic uses as well as habitat for diverse range of aquatic animals. The water quality of the stream is a critical indicator of its overall health value and any pollution or degradation can have far reaching consequences for both human health and the environment. One of the major sources of contaminants of Nwamgboko stream is the discharge of effluent from Kwata abattoir. The abattoir effluent is made up of liquid and solid wastes from livestock slaughter house (A place where animals are slaughtered for human consumption) into the environment or perhaps the streams. This wastewater contains contaminated liquids and organic materials such as faeces, urine, blood, carcasses, undigested foods, meat particles etc. This vast volume of effluent may contain varying concentration of physicochemical and microbial contaminants may have devastating impacts on the stream ecosystem which can be hazardous to the aquatic life of the stream (Pandey and Tiwari, 2021).

The direct impacts of abattoir wastewater on aquatic biodiversity are profound. The alteration of habitat quality and the introduction of toxins can lead to shifts in species composition, with more tolerant species dominating the community while sensitive species decline or disappear (Udeakanuah et al., 2021). This loss of biodiversity can destabilize ecosystems, reducing their resilience and ability to provide essential services such as water filtration, habitat provision, and nutrient cycling (Nafanda, 2020). Furthermore, the bioaccumulation of toxins within aquatic food webs can have cascading effects, affecting higher trophic levels, including fish and aquatic mammals (Neboh, 2023).

The implications of abattoir effluent on human health are also a critical concern. Contaminated water bodies can serve as reservoirs for pathogens and toxins, posing risks to communities relying on these water sources for drinking, recreation, and agriculture (Kumar and Singh, 2020). Consumption of contaminated fish and seafood can lead to severe health issues, including gastrointestinal diseases and long-term exposure effects from bio accumulated toxins (Osakwe, 2022). The economic impact of these health risks, alongside the degradation of aquatic ecosystems and the services they provide, can be significant.

The implications of abattoir effluent on aquatic ecosystems are multifaceted, encompassing water quality degradation, nutrient loading, biodiversity loss, and human health risks. It is critical to implement effective waste management strategies and treatment processes to mitigate the detrimental effects of these effluents on aquatic environments. Moving forward, collaborative efforts among industries, governments, and communities are vital to protect and restore aquatic ecosystems affected by abattoir effluent (Abattoir Acts, 2019).

1.1 Water Quality Parameters Review

The availability of safe and uncontaminated water is important for general public health; no matter its application (drinking, domestic use, food production or recreational purposes). According to World Health Organization (WHO), a country's economy can be boosted through better water resources management, mostly in the area of water supply and sanitation, and can contribute greatly to poverty alleviation (WHO 2008). Availability of clean water supply is one major concern in most parts of the world, especially in developing and underdevelopment countries of the world. About 785 million (about 13%) of the world 6.8 billion population lack safe drinkable water, this figure includes 144 million population that are dependent on surface water (Bahi and Kumar, 2021). Nigeria is among four West African countries where less than half of the population can access safe drinking water, according to the United Nations data. Due to the scarcity of drinking water in most parts of the world, mostly in Africa countries, the United Nations General Assembly (UNGA) in 2010 explicitly recognized access to safe water and sanitation as fundamental human right. Therefore, everybody has the right to sufficient, continuous, safe, acceptable, physically accessible, and affordable water for personal and domestic use. Industrial and domestic effluents can contribute major health hazard to the public if not properly treated (managed) before they are discharged into the environment. Water quality is drastically affected by untreated effluents discharged directly into the environment, which later find their ways to the water bodies (Udeakanuah et. al., 2021). In most developing and under-developed countries, effluent obtained from agricultural products processing, industrial and domestic activities are discharge into water bodies without proper treatment. This attitude had led to about 80% occurrences of endemic and epidemic gastrointestinal (cholera, diarrhoea, dysentery, hepatitis A, typhoid, and polio) diseases in the world, mostly in Nigeria. Even though diarrhea is a highly preventable disease, approximately 829 000 people die every year from diarrhea globally (Egharevba and Odjada, 2022).

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1.2 Escherichia coli

Escherichia coli, also known as E.coli are seen in large amount in the human excreta and practically that of all warm – blooded animals and hence is an indicator of recent faecal pollution of water; (WHO 2008). Confirmation tests for E.coli include β - glucuronidase, Gram staining, absence of urease activity. E.coli are a Gram – negative, non – spore forming, rod - shaped bacterium that can be motile or non – motile. It grows aerobically or facultatively. Metabolism involves both respiratory and fermentative processes (Choudhury and Bora, 2018).

Health Effects

E.coli is a common intestinal bacterium and majorly of strains that are non – pathogenic. However, subtypes capable of causing gastrointestinal disease are as well noticed. These pathogenic E.coli strains induce intestinal disease through a number of methods. Salmonellae - caused infections can look like cholera, dysentery or gastronenteritis. There are four types of pathogenic E.coli that cause diarrhea: enteroinvasive, enteropathogenic and enterotoxigenic. The first Enteropathogenic subtypes of E.coli were identified through serological investigation of strains isolated from newborn diarrhoea outbreaks. Although specific serotypes have been linked to disease, the underlying pathogenic mechanisms for the majority of these pathogens remain unknown. These strains are particularly linked to epidemics of infantile gastroenteritis.

1.3 Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) are reasonably connected with the aggregate mineral content in water (residues remaining after evaporation of water sample), which consists mostly of salts, carbonates and metals. Dissolved solids can also be in form of organic compounds. A high TDS content indicates potential high amount of pollution and further investigation could be necessary.

1.4 Total Suspended Solids (TSS)

When it rains, Total Suspended Solids (TSS) are released from cultivated fields, farmlands, building and logging sites, eroded stream banks and strip-mined land. As these deposits enter the lakes, rivers, coastal waterways, wetlands and rivers, they impair fish respiration and limit plant productivity and depth of water. Aquatic lives are smothered, reducing the aesthetic of the water (Nwankwo et. al., 2022).

1.5 Turbidity

Light is reflected or absorbed by Solid particles suspended in water, making the water appear "cloudy". These particles consist of suspended inorganic minerals or vegetal that have been brought up above or below earth. For the fact that the earth functions as an efficient filter, water from deep wells is always clean and turbidity free. This issue is more frequent with surface water. Turbidity is widely an aesthetic issue, but suspended materials may as well reflect infectious contamination. Reasonable number of organic debris can also leave stains on sinks and clothes (WHO 2008).

1.6 Nitrogen

Nitrogen in water and waste water are of four categories namely ammonia nitrogen, organic nitrogen, nitrite nitrogen and nitrate nitrogen. Nitrites and nitrates are formed by microbial transformation of greater percentage of organic nitrogen and ammonia through water contamination by sewage (Neboh, 2023). Nitrogen in the form of nitrate is a primary nutrient for plants growth and can also constitute a factor for growth limiting nutrient.

Elevated nitrate levels in surface water can trigger fast algae growth which potentially reduces the quality of water. Nitrates can be found in groundwater through infiltration of chemical fertilizers used in agricultural farmlands. Too much nitrate amount (greater than 10 mg/L) in drinking water may result in instant and severe health risk to newborns. The nitrate ions react with blood hemoglobin thereby causing a reduction in the ability of blood to carry oxygen resulting in a disease known as blue baby or methemoglobinemia (Neboh, 2023).

1.7 Nitrate (NO3)

Nitrates (NO3) are not usually adsorbed by soil and so moves with water. According to Nwankwo et. al., 2022, nitrates are mostly available in water around farmlands or regions where of high agricultural fertilization application. Industrial and Municipal wastewater, septic tanks, feedlot discharges from car exhausts are other important channels for nitrogen into water bodies. The nitrate concentration in drinking water is very important for infants, due to their high intake in water as regards their body weight. Nitrates in infants are usually converted to nitrites that oxidize blood haemoglobin to methaemoglobin.in the body. The bloods cells that are altered can no longer transport oxygen to the brain resulting to brain damage or suffocation. Nitrite level in water more than 1.0 mg/l should not be considered for feeding infants.

1.8 Acidity

Hydrogen Proportion (pH) measures acidity or alkalinity of a solution. Water with pH ranging from 6.0 to 9.0 provides protection for life of freshwater such as fish and invertebrates. Most enzymes and proteins have low pH differing much from pH 7.0 which can alter proper functioning of the organism or may even kill it. Low pH increases and triggers the release of toxic metals from soils and sediments. On the other hand, alkalinity is an important parameter that measures the capability of water to withstand acidity, such as acid rain. The important environmental effect of pH in water is its influence on certain chemical materials to become toxic (Udeakanuah et. al., 2020).

2. MATERIALS AND METHODS

2.1 Water Sampling Strategy

The sampling strategy used in this study involved collecting water samples from the abattoir discharge point, upstream and downstream at interval of 15 meters.

2.2 Sampling

Water samples were collected using pre-cleaned glass bottles with stopper and stored in ice coolers to prevent bacterial growth and were taken to home water laboratory at Awka for analysis.

2.3 Analysis for physicochemical parameters

1. Total Dissolved Solids (TDS) and Total Suspended Solids (TSS): A filtered water sample quantity of 100ml was oven-dried in a beaker. The difference in the weight of the empty beaker and the oven dried content was used to estimate the TDS. While a 100 ml of the water sample was selected. The selected volume of sample was poured into the filtration apparatus and allowed through filter into the filter flask. The measuring cylinder was rinsed into the filtration apparatus with three successive 10 ml portions of distilled water and allowing complete drainage between each rinsing. The filter was dried in an oven at 1050C. The filter was taken out of the oven and cooled in a desiccator to room temperature, weighed and the TSS was estimated.

2. Turbidity: This was done using the Digital turbidity meter calibrated with distilled water. The digital turbidity meter was switched on and allowed to warm up. The required turbidity range was selected for measurement and the display was adjusted to 000 by adjusting the Set Zero Knob. The test tube containing distilled water was removed and another test tube was filled with standard solution of 400 NTU as per the expected turbidity range of the unknown solution, and placed in the test tube holder. The measurement of the solution suspension was taken and the calibrate knob was adjusted so that the display read the selected standard solution value. The display zero was checked with the test tube containing distilled water. The test water samples in the various test tubes were in turns placed in the test tube holder, closed and the measurement of the turbidity value of each test water sample was read and recorded.

3. Test for water sample temperature

The temperature was measured using a centigrade thermometer. This was done by immersing the thermometer vertically into a beaker containing the water sample. The thermometer was thereafter allowed to stand until the reading stabilized and the value was taken and recorded.

4. Test for water sample pH level: The pH paper strips were used, the pH paper strips were obtained from a pharmacy store. A strip was collected and then inserted into the sample, the strip was held for about 10-15 seconds to allow it to absorb the sample. The striped was then removed from the sample and compared to the color chart provided with the pH paper strips. The strip color was then matched to the color of the corresponding pH range on the chart to determine the acidity or basicity of the sample.

5. Nitrate, Phosphate and Ammonium: The water samples were analyzed for these chemical contents using “AQUANAL Fishwater Lab” water testing kit. In this method, appropriate volumes of the samples of water in the specified test tubes were tested using the designed reagents for the chemical parameter by adding the reagents to the standard prescribed number of drops. The samples were shook and allowed to stand for a maximum period of 10 minutes and matched to a color chart. The color matching the medium on the chart corresponds to the concentration of the chemical parameter measured in mg/l.

2.4 Analysis for microbial parameters

The reagents used for the microbial test were Nutrient agar, MacConkey agar, salmonella shigella agar, sucrose, lactose, glucose, normal saline, peptone water, ringer solution. Each of the agar were prepared according to the manufacturer’s guide. 1 ml of each of the samples was taken and put into the 9 ml of distilled water. The dissolved

MacConkey agar, salmonella shigella agar and nutrient agar were distributed in ten different petri dishes. 0.1 ml from selected dilutions was incubated in petri dishes. The media for isolation were poured Using pour plate into each plate and incubated at for 24 hours at 37o C.

The solid culture media such as nutrient agar, salmonella agar and MacConkey agar used for the isolation and recording of the microorganisms present in the water sample were sterilized in the autoclave for 15 minutes at a temperature of 121oC. In the first tube, 9 ml of the sample was added to all the five tubes. 1ml of each sample was added to tube 1, mixed and stirred to tube 2, up to the last tube being the fifth tube. 1ml of each dilution was distributed into a sterile glass petric dish using fresh steriled pipette for each dilution. The sterile motten MacConkey agar, salmonella shigella agar and nutrient agar were aseptically poured into peltry dish containing the samples. These were well mixed by swirling the plate gently and then allowed on the bench to set. The plates were incubated at 37oc for 24 hours after solidification. The tube with higher dilution and the lowest concentration that showed visible growth (1 – 300) were counted and the number of colonies was recorded.

Cultural morphology: The size, shape, pigmentation, marginal and elevation characteristics of the different species of bacterial were examined in MacConkey agar, nutrients agar and salmonella shigella agar plates after appropriate incubation period. The isolated colonies were identified based on their cultural morphology on the three agar plates. The identified colonies were sub – cultured onto peptone water bottle and fresh MacConkey agar, nutrient agar and salmonella shigella agar in a fresh agar plate for further identification. There inoculated bottle and agar plates for each colony were incubated at 37oc for 24 hours. The pure cultures were gram stained each with gram reagents. The pure culture were further inoculated into citrate agar slate, carbohydrate sugar and water bottle containing 1% of each to help identify the isolated to a specific level. Those media were inoculated for 24 hours at 37oc. The organisms isolated from the sample included the following: E.coli, staphylococcus, shigella and salmonella.

3. RESULTS AND DISCUSSION

3.1 Physicochemical and microbial Tests Results

The physicochemical and microbial that were analyzed in the water samples are presented in Table 1 below.

Table 1: Physicochemical and microbial tests results of water samples

Water Quality Parameter	Sample Collection Point (CP)				Mean Value	NSDWQ (2007)	WHO (2008)	Remark
	CP1	CP2	CP3	CP4				
TDS (mg/l)	72	94	85	79	82.5	500	500	Okay
TSS (mg/l)	361	826	682	604	615.25	NS	NS	Not okay
TS (mg/l)	433	920	767	683	700.75	-	-	Not okay
Turbidity (NTU)	8.0	31.0	22.0	15.0	19.0	5.0	5.0	Not okay
Temperature (℃)	28.2	32.8	31.6	30.5	30.8	23 – 27	23 – 27	Not okay
pH level	6.7	7.8	7.4	6.9	7.2	6.5 – 8.5	6.5 – 8.5	Okay
NO_3 (mg/l)	7.5	12.0	10.5	10.0	10.0	50	10	Okay
PO_4 (mg/l)	0.18	2.84	1.97	1.12	1.53	0	0	Not okay
NH_4 (mg/l)	2.06	4.68	4.23	3.87	3.71	NS	0.5	Not okay
E.coli (cfu/ml)	5.0	16,500	14,000	12,600	10,776.25	0	0	Not okay
Microbial Count (TCC) (cfu/ml)	146	216	178	157	174	0	0	Not okay
BOD (mg/l)	174	674	328	271	362	30	30	Not okay
COD (mg/l)	421	1545	854	680	875	NS	NS	Not okay
DO (mg/l)	3.55	1.48	2.65	3.22	2.73	2.0	2.0	Not okay

3.2 Discussion of Physicochemical Results

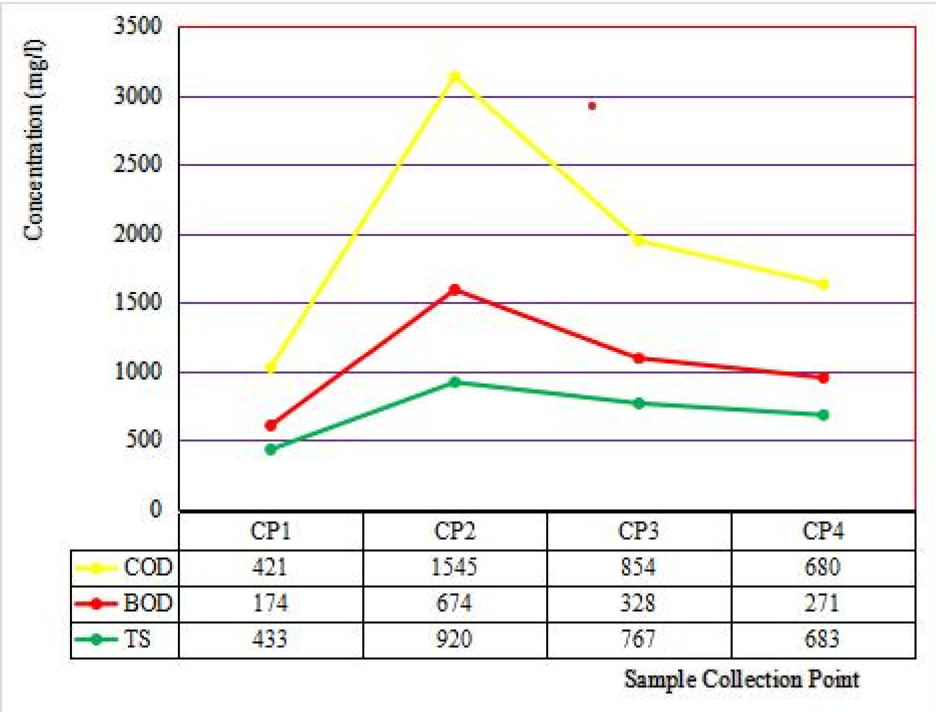
The results in Table 1 above showed that the mean concentrations of Total Dissolved Solids (TDS), pH and Nitrate (NO3) in water sampled from four (4) different locations before and after the abattoir wastewater discharge point in Nwamgboko stream were 82.5 mg/l, 7.2 and 10.0 mg/l respectively which were within the maximum allowable limit set by (NSDWQ 2007) and (WHO 2008) while the mean concentrations of Total Suspended Solids (TSS), Turbidity, Temperature, Phosphate (PO4) and Ammonium (NH4) were 615.25 mg/l, 19.0 NTU, 30.8 , 1.53 mg/l and 3.71 mg/l respectively and were above the maximum allowable limit set by NSDWQ (2007) and WHO (2008).

3.3 Discussion of Microbial Results

The results in Table 1 above showed that the mean concentration of E.coli, Total coliform count (TCC), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Dissolved Oxygen (DO) in water sampled from four (4) different locations before and after the abattoir wastewater discharge point in Nwamgboko stream were 10,776.25 cfu/ml, 174 cfu/ml, 362 mg/l, 875 mg/l and 2.73 mg/l respectively which were above the maximum allowable limit recommended by (NSDWQ 2007) and (WHO 2008). These tests results showed that water samples collected at the downstream of the abattoir discharge point of the stream possessed higher microbial contamination owing to the injection of faecal and organic materials from the slaughter house.

3.4 Graphical presentation of the trend of Total Solids (TS), BOD and COD

The trend of TS, BOD and COD with respect to the water samples collection points is presented in Figure 1.



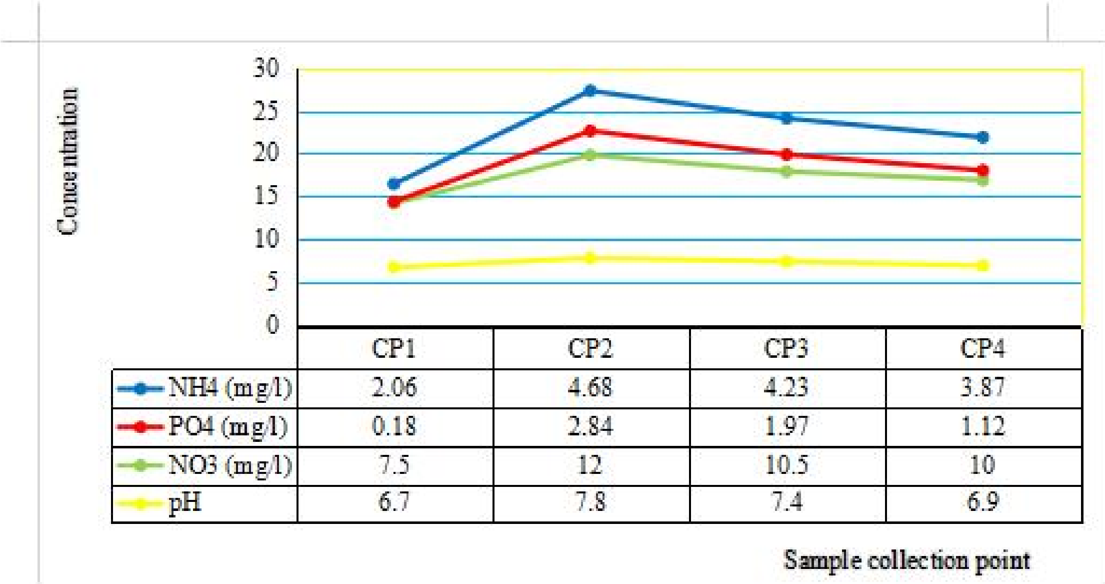
Source: Uchendu et. al., 2025.

Figure 1: Trend of TS, BOD and COD in water samples at different collection points

The graph in Figure 1showed a visibly wide variance in TS, BOD and COD at abattoir wastewater discharge point compared with other water sample collection points.

3.5 Graphical presentation of the trend of pH, NO3, PO4 and NH4 in Nwamgboko stream

The trend of pH, NO3, PO4 and NH4 with respect to the water samples collection points is presented in Figure 2.



Source: Uchendu et. al., 2025.

Figure 2: Trend of pH, NO3, PO4 and NH4 in water samples at different collection points

The graph in Figure 2 showed a visibly wide variance in NO3, PO4 and NH4 against the pH level across the water sample collection points.

4. CONCLUSION

This research work on assessment of the impact of abattoir effluent on stream water quality has evaluated the significant contaminants and health risks due to elevated levels of physicochemical and microbial contents of Nwamgboko stream in Amikwo Awka, Anambra State. The work revealed the immediate need for addressing the adverse environmental impacts of inadequate slaughter waste management and practices in the livestock - food processing sector. The observed contamination levels revealed the potential consequences of unregulated industrial discharges of untreated effluent into water courses and emphasized the need for immediate precautionary action to mitigate these adverse impacts.

In conclusion the effect of abattoir effluent on stream water quality highlighted significant ecological concerns. The findings underscore the need for effective management practices to mitigate adverse effects on water systems and aquatic life. By addressing these challenges and focusing towards sustainable agricultural and industrial practices that protect vital water resources and promote beneficial and sustainable ecosystems.

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