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THE IMPACT OF ABATTOIR EFFLUENT DISCHARGE ON THE WATER QUALITY

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ABSTRACT

This study evaluates the impact of abattoir effluent discharge on the water quality of Baboko Stream in Kwara State, Nigeria, and its implications for soil fertility and crop yields in the Baboko Irrigation Scheme. Abattoir effluent, containing high levels of nutrients, heavy metals, pathogens, and organic matter, poses significant environmental risks. The study aimed to assess water quality, soil properties, and crop yield trends to inform sustainable waste management practices. A descriptive research design was employed, with water samples collected from

Introduction

Improper waste disposal remains a critical environmental challenge, particularly in developing countries where regulatory frameworks and waste management infrastructure are often lacking. In Nigeria, abattoir effluent discharge into surface water bodies contributes significantly to environmental pollution, threatening water quality, soil productivity, and public health. Abattoirs generate substantial amounts of

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upstream, midstream, and downstream locations, and soil samples taken at three depths (0-20 cm, 20-60 cm, and 60-100 cm) along irrigation sites. Laboratory analysis was conducted to determine water quality parameters, including Potential of Hydrogen (pH), electrical conductivity, and nutrient concentrations, and soil properties such as texture, organic matter, and cation exchange capacity. The sodium adsorption ratio (SAR) was also calculated to assess irrigation suitability. Results indicated moderate salinity in the water, though sodium levels exceeded the guidelines set by the Food and Agriculture Organization (FAO), raising concerns about soil sodicity. Crop yield analysis revealed a decline in lettuce productivity, likely due to elevated sodium levels, while yields of okra and pepper remained stable. The study recommends improved waste management, effluent treatment, and sustainable agricultural practices to mitigate environmental impacts.

Keywords: Abattoir effluent, water quality, soil fertility, irrigation, environmental sustainability, Baboko Stream

Wastewater laden with organic and inorganic pollutants, including pathogens, fats, oils, blood, and heavy metals.

The Baboko Stream in Kwara State, Nigeria, is one such water body impacted by unregulated effluent discharge from the Oja-tuntun Abattoir. This stream is a vital resource for the Baboko Irrigation Scheme, supporting the livelihoods of numerous farmers who rely on it for crop cultivation. However, untreated abattoir waste has been reported to alter the physicochemical properties of water, making it unsuitable for irrigation and posing long-term risks to soil fertility and food security. Studies by Omole and Longe (2019) highlight similar issues in other regions, emphasizing the urgency of addressing this challenge.

This study investigates the extent of water and soil contamination caused by abattoir effluent discharge into the Baboko Stream. By assessing key water

quality parameters, soil characteristics, and crop yield trends, the research aims to inform sustainable waste management practices that ensure environmental integrity and agricultural productivity.

LITERATURE REVIEW

Abattoir waste management has garnered significant attention due to its environmental and public health implications. Approximately 90% of wastewater generated by abattoirs remains untreated, contributing to widespread water pollution (Jhansi, 2021). In developed countries, stringent environmental regulations have driven the adoption of advanced wastewater treatment technologies, such as constructed wetlands and phytoremediation. However, in developing nations like Nigeria, the lack of infrastructure and enforcement mechanisms exacerbates the problem.

Studies have shown that abattoir effluents significantly alter the physicochemical properties of water bodies. Elevated levels of biochemical oxygen demand (BOD), chemical oxygen demand (COD), and nutrients such as nitrogen and phosphorus are common in abattoir wastewater (Adeyemo et al., 2022). These pollutants reduce dissolved oxygen levels, disrupt aquatic ecosystems, and promote eutrophication. Heavy metals such as lead and cadmium, often found in abattoir effluents, pose additional risks by bioaccumulating in aquatic organisms and entering the food chain (Ibrahim et al., 2018).

The degradation of water bodies from abattoir effluents not only threatens ecosystems but also impacts the livelihoods of communities that depend on these resources. Waterborne diseases, reduced agricultural yields, and higher water treatment costs are some of the direct consequences. According to Omole and Longe (2019), addressing this challenge requires a multi-pronged approach involving policy enforcement, stakeholder collaboration, and community education.

MATERIALS AND METHODS

Study Design

A descriptive research design was employed to investigate the effects of abattoir effluent discharge on water and soil quality, as well as crop yields in the Baboko Irrigation Scheme. This design facilitated the systematic collection, analysis, and interpretation of data from both field and laboratory sources.

Study Area Description

The Baboko Stream is located in Ilorin West Local Government, Kwara State, Nigeria. It lies within a transitional zone between the southern Nigerian climate and the semi-arid Sudan savannah of northern Nigeria. The stream serves as the primary water source for the Baboko Irrigation Scheme, which supports the cultivation of crops such as lettuce, okra, and pepper. The Oja-tuntun Abattoir, situated along the stream, discharges untreated wastewater directly into the water body.

Sampling Procedure

Water Sampling:

Three water samples were collected from upstream, midstream, and downstream points of the Baboko Stream. Sampling was conducted at 11:00 a.m. to capture the peak effluent discharge from the abattoir. Samples were collected in sterilized 5-liter plastic containers, sealed, and transported to the laboratory for analysis.

Soil Sampling:

Soil samples were collected from three depths (0-20 cm, 20-60 cm, and 60-100 cm) at irrigation sites along the stream. A soil auger was employed for sample extraction. The samples were air-dried, sieved through a 2-mm mesh, and stored in labeled polythene bags for laboratory analysis.

Laboratory Analysis

Water Quality Analysis

- **Potential of Hydrogen (pH) and Electrical Conductivity (EC):** Measured using a digital pH meter and EC meter, respectively.
- **Nutrients:** Nitrate, ammonium, and phosphorus levels were determined using spectrophotometric methods.
- **Sodium Adsorption Ratio (SAR):** Calculated to evaluate the suitability of water for irrigation using the formula

Soil Analysis

- **Texture:** Determined using the hydrometer method.
- **Organic Matter (OM):** Measured using the Walkley-Black method.
- **Cation Exchange Capacity (CEC):** Measured using ammonium acetate extraction.
- **Exchangeable Sodium Percentage (ESP):** Calculated as the ratio of exchangeable sodium to total cation exchange capacity.

Justification for Methods

The chosen methodologies ensured the accurate assessment of water and soil quality parameters critical to understanding the impacts of abattoir effluent. Sampling locations and depths were strategically selected to capture variations influenced by effluent discharge. Laboratory methods adhered to international standards, ensuring reliable and replicable results.

Study Population and Sample Size

The study targeted water from the Baboko Stream and soil from adjacent irrigation sites. Crop yield data were obtained from farmers operating within the Baboko Irrigation Scheme. A total of nine water and soil samples were analyzed, covering a representative cross-section of the study area.

Limitations

Potential limitations include seasonal variations in effluent discharge that may affect water and soil quality. Additionally, the study focused on specific crops (lettuce, okra, and pepper), which may limit the generalizability of findings to other crops or regions.

RESULTS AND DISCUSSION

Water Quality Analysis

The results from the laboratory analysis of water samples revealed moderate salinity levels with electrical conductivity (EC) ranging from 0.20 to 0.30 dS/m. These values fall within acceptable limits for irrigation, as per Food and Agricultural Organization (FAO) guidelines. However, sodium levels exceeded recommended thresholds, with a Sodium Adsorption Ratio (SAR) ranging from 2.2 to 3.8 across the sampling sites. Elevated sodium levels indicate potential risks for soil sodicity, which could adversely affect soil structure and water infiltration.

Table 1: Water Quality Parameters

Parameter	Unit	Upstream	Midstream	Downstream
Electrical Conductivity (EC)	dS/m	0.30	0.20	0.23
Sodium Adsorption Ratio (SAR)	-	3.8	2.2	3.5
Total Dissolved Solids (TDS)	mg/L	120	330	170
Sodium (Na)	me/L	11.7	9.12	12.8
Nitrate-Nitrogen (NO3-N)	mg/L	0.60	0.20	0.28

Soil Quality Analysis

Soil analysis indicated a sandy loam texture across all sampling locations, characterized by low moisture retention but adequate aeration. Organic matter content ranged from 0.133% to 0.165%, reflecting moderate fertility

levels. Cation exchange capacity (CEC) values ranged between 4.76 and 5.52 meq/100g, indicating moderate nutrient retention capability. Exchangeable Sodium Percentage (ESP) values, ranging from 5.90% to 10.00%, highlighted potential risks of sodicity, particularly in areas irrigated with high-sodium water.

Table 2: Soil Chemical Properties

Depth (cm)	pH	OM (%)	CEC (meq/100g)	ESP (%)	Texture
0-20	6.52	0.165	5.52	10.00	Sandy Loam
20-60	5.30	0.133	4.76	9.11	Sandy Loam
60-100	6.87	0.142	5.34	5.90	Sandy Loam

Crop Yield Trends

Crop yield data from 2021 to 2023 revealed a decline in lettuce productivity, attributed to increased sodium levels affecting soil structure and nutrient availability. Conversely, okra and pepper yields remained stable, suggesting resilience to changes in soil and water quality. Lettuce yields decreased from 8,500 kg/ha in 2021 to 7,000 kg/ha in 2023, whereas okra and pepper yields averaged 4,500 kg/ha and 1,500 kg/ha, respectively.

Table 3: Crop Yield Trends

Crop	2021 Yield (kg/ha)	2022 Yield (kg/ha)	2023 Yield (kg/ha)
Lettuce	8,500	7,700	7,000
Okra	4,500	4,500	4,500
Pepper	1,500	1,500	1,500

Discussion

The findings corroborate previous studies indicating that high sodium levels in irrigation water can lead to soil degradation and reduced crop yields. The

moderate organic matter content and CEC suggest that while the soil is currently productive, ongoing exposure to high-sodium irrigation water could exacerbate fertility decline. The decrease in lettuce yield highlights the crop's sensitivity to salinity, emphasizing the need for alternative crop choices or improved soil management practices.

The persistence of stable yields for okra and pepper indicates their relative tolerance to changes in soil and water quality, aligning with findings from other regions. This suggests opportunities to diversify crop selection based on salinity tolerance. The observed sodium levels underline the importance of integrating effluent treatment solutions to mitigate long-term environmental risks.

Comparative studies demonstrate that untreated abattoir effluent introduces organic and inorganic pollutants into water bodies, with cascading effects on soil health and agricultural sustainability. The need for periodic soil testing and the development of site-specific remediation strategies cannot be overstated. Future research could explore the efficacy of bio-remediation techniques or the introduction of buffer zones around abattoir facilities to minimize pollutant loads.

CONCLUSIONS

This study underscores the significant environmental and agricultural impacts of abattoir effluent discharge on the Baboko Stream and its irrigation scheme. Although water quality parameters largely met irrigation suitability standards, elevated sodium levels presented risks to soil health and crop productivity. Lettuce yields declined over three years, illustrating the impact of salinity on sensitive crops, while okra and pepper yields remained stable due to their tolerance.

To ensure sustainable agricultural practices in the Baboko Irrigation Scheme, immediate interventions are recommended, including effluent treatment systems, crop diversification, and enhanced soil management practices.

Regular monitoring and stricter regulatory enforcement are crucial to maintaining the long-term viability of water and soil resources. Future studies should investigate advanced remediation techniques and explore economic incentives for adopting sustainable waste management practices.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed:

1. **Regular Monitoring**: Implement periodic testing of water and soil quality to detect and address emerging issues promptly.
2. **Effluent Treatment**: Introduce abattoir wastewater treatment systems to reduce sodium and other contaminants before discharge.
3. **Crop Selection**: Encourage the cultivation of sodium-tolerant crops and rotation practices to maintain soil health.
4. **Farmer Training**: Provide training on sustainable irrigation practices and soil management to mitigate the effects of sodicity.
5. **Policy Implementation**: Advocate for stricter enforcement of environmental regulations to ensure compliance with waste management standards.

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