JASEM ISSN 1119-8362

Full-text Available Online at www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage. *December*, 2009
Vol. 13(4) 35 - 38

# Seasonal Distribution of Nitrate and Nitrite Levels in Eleme Abattoir Environment, Rivers State, Nigeria.

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**ABSTRACT:** The study deals with the seasonal distribution of nitrate ($NO_3$) and nitrite ($NO_2$) levels in Eleme Abattoir environment. Samples of soil, surface water and groundwater were collected from areas unaffected and those affected by abattoir activities. For the soils from the affected area and control points respectively, nitrate levels were 2.42 mg/l and 1.30 mg/l in wet season and 12.0 mg/l and 6.40 mg/l in dry season. The corresponding values for nitrates were <0.02mg/l and <0.02mg/l in wet season and 71.1mg/l and 62.5mg/l in dry season. Surface water samples showed nitrate composition of 0.99mg/l and 0.69mg/l in wet season and 0.44mg/l and 0.26mg/l in dry season in affected and unaffected areas, respectively. The respective concentrations of nitrates were <0.02mg/l and <0.02mg/l, and 0.70mg/l and 0.35mg/l. For the groundwater, nitrates during the dry and wet seasons were 0.28mg/l and 0.70mg/l whereas those of nitrates in both dry and wet seasons were 0.35mg/l and <0.02mg/l, respectively. In both seasons, the nitrate and nitrite levels in the surface and groundwater of the study area fall within the WHO levels, but in the dry season, unsafe levels prevail in the soil affected by abattoir activity. It is recommended that there should be periodic evaluation of nitrate and nitrite levels in the area. @ JASEM

Animal waste is a major route of entry of nitrogen and nitrogen containing compounds into the soil, surface and groundwater. In Nigeria, meat processing activities are carried out in unsuitable buildings by untrained slaughter men and butchers unaware of sanitary principles (Edward, 1979; Olanike, 2002).

The concept of abattoir has been misconstrued in Nigeria. An abattoir is a premises approved and registered by controlling authorities, for hygienic slaughtering, inspection, processing, effective preservation and storage of meat products for human consumption (Alorge,1992). An abattoir waste can be technically defined as waste or waste water from abattoir which could consist of pollutants such as animal faeces, blood, fat, animal trimming and urine (Anonymous, 2001). Abattoir activities produce highly organic wastes with relatively high levels of suspended solid, liquid and fat and these organic wastes contain among other contaminants nitrate and nitrite and therefore have the capacity to contaminate soil, air, surface and groundwater (Meadows, 1995).

Olanike (2002) and Tielen(2000) described unmanaged abattoir wastes as products that are at best, an embarrassment or nuisance, and at worst, serious pollutants. Various studies on abattoir by Alorge (1992), Abiola (1995), and Aniebo (1994), have revealed that nitrites ($NO_2$) can produce " brown blood disease" in fish. Nitrites also react directly with hemoglobin in human blood and other warm-blooded animals to produce Methemoglobin. Methemoglobin destroys the ability of red blood cells to transport oxygen.

Nitrate ($NO_3$) on the other hand is a major potential groundwater contaminant. It is absorbed from the digestive track and excreted rapidly in the urine of older children and adults. Infants younger than 6 months of age are susceptible to nitrate poisoning (Mahler, 1992). Owing to the numerous health and environmental hazards caused by unsafe disposal of abattoir waste, this study was therefore undertaken to evaluate the seasonal levels of nitrate and nitrite in Eleme abattoir environment and make recommendations.

## MATERIALS AND METHODS

### Sample Collection

Soil, surface and groundwater samples were collected from the study area in both wet and dry seasons. Water samples were collected in 2 litre polyethylene plasic cans properly sealed and labeled using masking tape, whereas the soil samples were collected in polythene bags properly sealed and labeled. The soil, surface and groundwater samples were collected from points very close to the abattoir (affected areas) and points about 60 metres away upstream from the abattoir (unaffected area). The samples were analysed for nitrite and nitrate levels.

*Analysis of Nitrite*: Nitrite level was determined by the Greiss method as described by Mongomery and Dymock (1961). Sample 1.0ml was pipetted into a thoroughly washed test tube and 0.5ml of 0.5% Sodium Carbonate solution was added. Exactly 1.5ml of sulphanilic acid solution (2.7g of potassium hydrogen sulphate and 3.64g of sulphanilic acid dissolved in 1 litre of distilled water) was added. This was followed by addition of 1.5ml N-(1- naphthaly)-ethylenediamine hydrochloric (NEDA) reagent (0.1g of NEDA in 250ml of distilled water. After mixing, the solution was allowed to stand for 10 minutes. The absorbance of the pink colour developed was read at 550nm in a Spectronic-20 Spectrophotometer (Milton Roy) against sodium nitrate standard solution. The

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nitrite value was measured from a standard curve for nitrite of concentration range of 0-2.5mg/ml $NO_2$.

*Analysis of Nitrate*: Nitrate level was analysed by the Bruccine Colorimetric method of the Association of Official Analytical Chemists (AOAC) (1980). Here, sample 1.0ml, was introduced into a clean dry test tube and 2.0ml of concentrated $H_2SO_4$ added in order to reduce nitrate to nitrite. The procedure for determination of nitrite was described above was read as described immediately above.

## RESULT AND DISCUSSIONS

The results of the analyses of the seasonal distribution of nitrate and nitrite in the soil, surface water and groundwater are presented in Tables I and II below. Tables III-VI and Figures 1 & 2 shows the comparisons of the results obtained while Table VII shows the ratios for soil, surface water and groundwater.

**Table 1:** Seasonal Distribution of Nitrate and Nitrite in Soil.

| Season | Nitrates (mg/l) | | Nitrites (mg/l) | |
|---|---|---|---|---|
| Wet | U | A | U | A |
| | 1.30 | 2.42 | <0.02 | <0.02 |
| Dry | 6.40 | 12.0 | 62.5 | 71.7 |

U= Unaffected soil
A = Affected soil

**Table 2:** Seasonal Distribution of Nitrate and Nitrite in Surface water and Groundwater

| Season | Nitrate (mg/l) | | | Nitrite (mg/l) | | |
|---|---|---|---|---|---|---|
| Wet | Usw | Asw | Gw | Usw | Asw | Gw |
| | 0.69 | 0.99 | 0.70 | <0.02 | <0.02 | <0.02 |
| Dry | 0.26 | 0.44 | 0.28 | 0.35 | 0.70 | 0.35 |

Usw = Unaffected surface water
Asw = Affected surface water
Gw = Groundwater

**Table 3:** Comparison of the levels of Nitrate and Nitrite in Soil in the Wet Season with WHO (1988) Standards

| | Unaffected | Affected | Safe | Unsafe |
|---|---|---|---|---|
| Nitrate levels (mg/l) | 1.30 | 2.42 | √ | |
| Nitrite levels (mg/l) | <0.02 | <0.02 | √ | |

**Table 4:** Comparison of the levels of Nitrate and Nitrite in Soil in the Dry Season with WHO (1988) standards.

| | Unaffected | Affected | Safe | Unsafe |
|---|---|---|---|---|
| Nitrate levels (mg/l) | 6.40 | 12.0 | √ | |
| Nitrite levels (mg/l) | 62.5 | 71.7 | | √ |

**Table 5:** Comparison of the levels of Nitrate and Nitrite in Surface and Groundwater in the Wet Season.

| | Unaffected Surface water | Affected surface water | Groundwater | Safe | Unsafe |
|---|---|---|---|---|---|
| Nitrate levels (mg/l) | 0.69 | 0.99 | 0.70 | √ | |
| Nitrite levels (mg/l) | <0.02 | <0.02 | <0.02 | √ | |

**Table 6:** Comparison of the levels of Nitrate and Nitrite in Surface and Groundwater in the Dry Season with WHO (1988) Standards.

| | Unaffected Surface water | Affected surface water | Groundwater | Safe | Unsafe |
|---|---|---|---|---|---|
| Nitrate levels (mg/l) | 0.26 | 0.44 | 0.28 | √ | |
| Nitrite levels (mg/l) | 0.35 | 0.70 | 0.35 | √ | |

**Table 7:** Calculated Ratios of Nitrate and Nitrite to WHO (1988) Guideline values.

| Season | Ratios for Soil | | Ratios for Surface and Groundwater | | | |
|---|---|---|---|---|---|---|
| | Nitrate | Nitrite | Nitrate | | | Nitrite |
| | | | Sw | Gw | Sw | Gw |
| Wet | 0.0484 | 0.0067 | 0.0198 | 0.014 | 0.0067 | 0.0004 |
| Dry | 0.24 | 23.9 | 0.0088 | 0.0056 | 0.2333 | 0.007 |

Sw = Surface water
Gw = Groundwater

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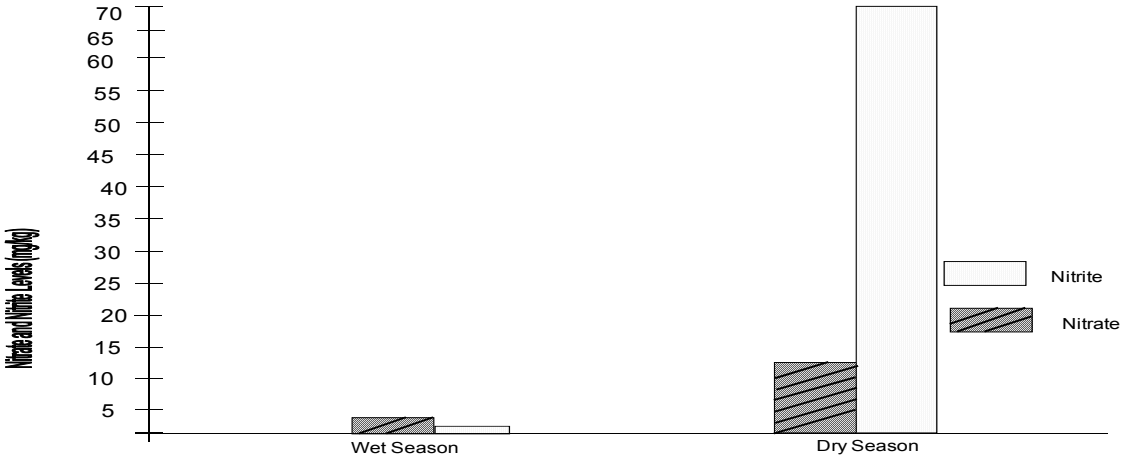


**Fig.1:** Seasonal distribution of nitrate and nitrite in soil

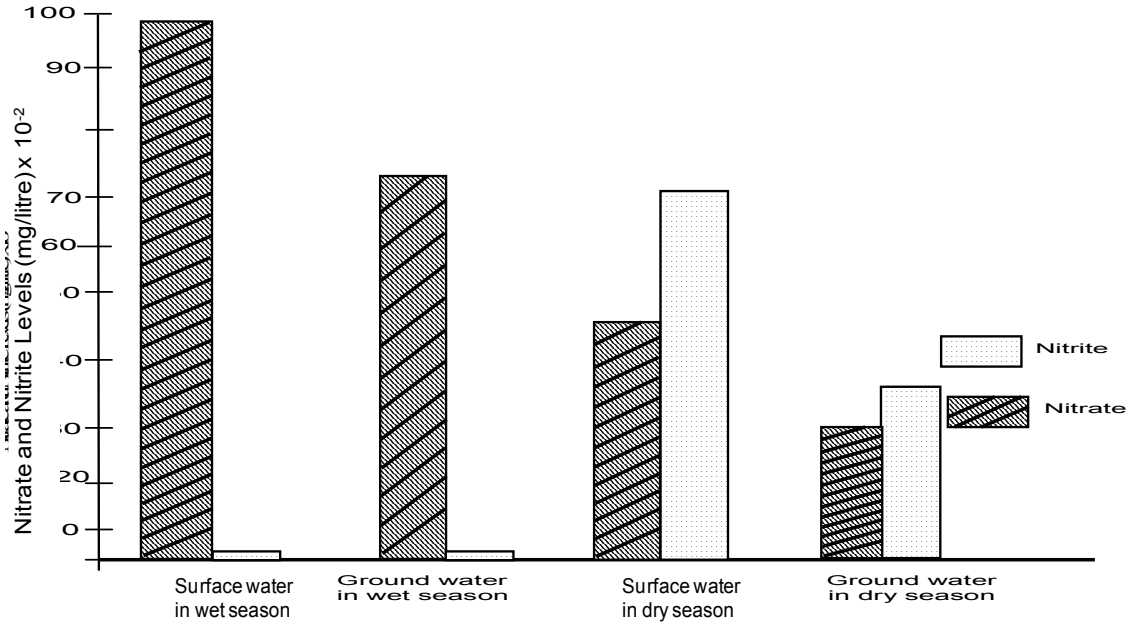


**Fig.2:** Seasonal distribution of nitrate and nitrite in both surface and groundwater

Table 1 shows that the nitrate levels in the soil of the study area is 2.42mg/l and nitrite level is <0.02mg/l in the wet season whereas in the dry season, the nitrate level is 12.0mg/l and nitrite level is 71.7mg/l. Similarly, Table 2 shows that the nitrate level in the surface water for the affected area is 0.99mg/l and groundwater is 0.70mg/l.Whereas nitrite level in surface water is <0.02mg/l and in groundwater is <0.02mg/l during the wet (rainy) season, but in the dry season, the nitrate level is 0.44mg/l and nitrite is 0.70mg/l for surface water and 0.28mg/l and 0.35mg/l, respectively for groundwater.

Low oxygen tension due to saturation with water in the wet season leads to rapid conversion of nitrate ($NO_3^-$) to nitrite ($NO_2^-$) –Denitrification (Dawson and Murphy, 1972). In such a condition, nitrite is expected to accumulate more than nitrate during the rains, but the result obtained from the laboratory analysis of the soil and water of the study area shows the reverse; nitrate accumulation is more than nitrite in the rainy season. This situation is traced to the reason that during the rains, the soil temperature is low and the oxygen tension is also low due to saturation with water.

The conversion of nitrate to nitrite is favoured by elevated temperatures (Dawson and Murphy, 1972). Since this is not the case in the wet season, nitrate accumulates, leading to high nitrate concentration observed in the wet season. In the dry season, the soil and water conditions are aerobic and this favours the rapid conversion of nitrite nitrate (Nitrification). Therefore, more nitrates are expected to accumulate than nitrites during the dry season. But the results obtained from the analysis of soil and water of the study area shows the reverse – nitrite accumulates more than nitrate. This is because, in the dry season, the temperature is high and therefore favours the conversion of nitrates to nitrites. In the same vein, the

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conversion of nitrite to gaseous nitrogen is sensitive to oxygen which abounds in the soil during the dry season. Hence, conversion of nitrite to gaseous nitrogen is inhibited. Nitrite therefore accumulates leading to the high concentration of nitrite observed in the dry season (Kornaros and Lyberatos, 1998).

The World Health Organization (WHO, 1988) has a guideline value of 50mg/l for nitrate and a provisional value of 3mg/l for nitrite. Because of the possibility that nitrate and nitrite could occur together in drinking water, the sum of the ratios of the concentration of each to its guideline value should not exceed 1. Tables 3, 4, 5 and 6 above compare the levels of nitrate and nitrite in both the affected and the unaffected areas with the WHO guideline values. Tables V and VI shows that the soil is contaminated with nitrite in the dry season and safe in the wet season, whereas the surface and groundwater of the study area are not contaminated with nitrate and nitrite in both seasons (Figures 1 & 2).

The study showed that during the rains, nitrate level is higher than nitrite whereas in the dry season, the nitrite level is higher. The ratio of the sum of nitrates and nitrites in the soil to their guideline values in the wet season is 0.0551 (Table 7) indicating that in the wet season, the environment is not contaminated. However, in the dry season, the value is 24.14 much greater than 1, indicating that the environment is polluted during the dry season conditions.

Similarly, nitrate and nitrite levels in the surface and groundwater during the wet season is 0.0265 for surface water and 0.0144 for groundwater (Table 7), whereas their levels in the dry season is 0.2421 for surface water and 0.0126 for groundwater, which are safe for the environment. The results generally show high accumulation of nitrate than nitrite in the wet season, whereas nitrites accumulate more than nitrates in the dry season.

*Conclusion*: Generally, the results showed that the levels of nitrate and nitrite in the soil, surface and groundwater of the affected and unaffected areas in the wet season are below the WHO (1988) guideline values for nitrate and nitrite. But in the dry season, the level of nitrite in the soil is higher than the prescribed guideline. This clearly indicates that the nitrogeneous compounds present in the soil, surface and groundwater during the dry season exceeds that during the wet season, and the level of nitrite in the soil during the dry season exceeds the WHO standard. This could be attributed to the greater abattoir activities in the dry season than in the wet season. It is therefore recommended that there should be periodic evaluation of nitrate and nitrite levels in the area since surface water and groundwater is a major source of domestic water supply, which will likely expose the large population of the area to health hazards due to long-term and cumulative effects these ions might have.

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