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IMPACT OF WASTE WATER ON IRRIGATION WATER QUALITY IN MINNA, NIGERIA.

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ABSTRACT

Irrigation water from two typical suburbs in Nigeria; namely Minna Abattoir and Maizube Farm were analysed to ascertain the impact of waste water on their quality. The parameters investigated include total dissolved solids (TDS), electrical conductivity (EC_w), pH, temperature, turbidity, biochemical oxygen demand (BOD), chemical oxygen demand (COD) and some major cations and anions found in the waste water. The analysis was replicated three times for each of the sampled sites. The results obtained were compared with international irrigation water quality standards. The study revealed that there were no adverse effects of the discharge effluents on the receiving watershed, and thus did not impair negatively on the quality of the irrigation water.

Keywords: Waste water, irrigation, water quality, conductivity, total dissolved solid.

1.0 INTRODUCTION

Waste water contains contaminants such as suspended solids, biodegradable organics, pathogens and nutrients. If untreated, these contaminants pose serious threat to life when they enter water ways and streams used as drinking water source. Livestock waste constitutes one of the major sources of contaminants in urban and sub-urban communities. The shorter life expectancy in the developing countries compared with the developed nations (WHO, 2002), has been ascribed partly to water contamination from effluents from various sources (Okoh et. al., 2007).

In Nigeria, most streams and water channels are being deposited with various forms of wastes, such as human faeces, livestock wastes, polyethylene bags (water satchets), leaves for wrapping food materials, non-useable metal scraps, among others. These water sources are being utilized both for irrigation and domestic use without treatment since potable water is grossly inadequate in Nigeria, even in urban centres. Therefore, a necessary and sufficient condition to safeguard public health and environment in Nigeria is the assessment of the quality of available water and waste water.

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In South Africa, Fatoki et al. (2003) evaluated the physico-chemical quality of Keiskamma river and the impoundment downstream of Eastern Cape and concluded that the level of electrical conductivity, nitrate, orthophosphate and oxygen-demanding substance were above the permissible limit. A recent study by Igbinosa and Okoh (2009) on the qualities of treated final effluents of a waste-water plant in rural Eastern Cape Province revealed that there was an adverse impact on the physico-chemical characteristics of the receiving watershed as a result of the discharge of inadequately treated effluents from the waste water facility.

With increase in population to 140 million going by the 2006 national census, the government of Nigeria is encouraging most Nigerians to go into agriculture. Productive agriculture in Nigeria is predicated on available and reliable water supply given the abundant solar radiation all year round. Therefore, irrigation agriculture holds the key to increased food production and food security. Quality of irrigation water depends on the amount of suspended sediment and chemical constituents in the water. In a study of surface and sub-surface water quality for irrigation in Allahabad, India, Isaac et al. (2008) chemically analysed various sources of water to check their suitability for irrigation and classified them according to the amounts of salt present.

Slaughtering animals in the abattoir gives rise to meat supply and useful by-products like leather and skin. However, livestock's wastes spill can introduce enteric pathogens and excess nutrients into surface water, and can also contaminate ground water (Meadow, 1995). Abattoir operations produce characteristic high organic wastes, with relatively high levels of suspended solids, liquids, and fats. The solid parts of the wastes include condemned meat, undigested ingesters, bones, horns, hair and aborted foetuses. The wastes are usually composed of dissolved solids, blood, guts contents, urine and water. With the growth in population, leading to rapid increase in urbanization, more water is required for several human activities including irrigation agriculture (Sani, 1993). Due to scarcity of water in different parts of Nigeria as a result of non-reliability of rainfall, treated and untreated waste waters are being used for agricultural purposes. Similar cases have been reported in Iran (Massoudinejad et al., 2006). Despites the numerous nutritional advantages of the use of waste water, untreated effluents may cause environmental problems. These problems may present themselves as suspended solids which may clog soil pods or dissolved compounds that may be toxic to plants and harmful to humans. The purpose of this study is to analyse the quality parameters of irrigation water at Maizube Farms and downstream of Minna Abattoir with a view to ascertaining the level of concentration or otherwise of the harmful parameters, so that farmers using the water could be appropriately advised. The study also attempts to assess the impact of the waste and waste water on the quality parameters of irrigation water used in this agricultural watershed.

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2.0 MATERIALS AND METHODS

2.1 Location of Study Areas

The study areas are Niger State Abattoir, Minna and Maizube Farm, all in Niger State, Nigeria. The location of Maizube Farm is about 30km from Minna the capital of Niger State and the Abattoir is a few kilometres from the capital city. The two locations are in the Southern Guinea Savannah zone of Nigeria and lies approximately on longitude 06^0 28" E and latitude of 09^0 35" N (Sani, 1993). The climate is characterized by one well-defined wet season that is unimodal, with a mean annual rainfall of about 553 mm, which normally begins in April/May; peaks in August and ends in October. The study area has a gentle slope upper slope of 1- 2%, which helps in the drainage of the field. The soil in the locations of study is sandy loam (Alfisol) (Owonubi *et, al.,* 1991).

2.2 Sampling Procedures

Samples of water were collected in the two suburbs (Maizube Farm, and Minna Abattoir). Samples were collected in Maizube Farm from the dam reservoir whose source of water is River Daga, a tributary of River Kaduna. Sampling in Minna abattoir was at 100m intervals beginning from the slaughter house all along the abattoir waste discharge channel (upstream and downstream of the discharge point). A total of four (4) samples were collected directly at the abattoir. The water flushing the discharge channel originates from the spring on the rocky hills of Tsaunin, Bosso in Bosso LGA of Niger State.

Samples were collected in tight capped bottles and later transported to the laboratory under low temperature conditions in ice-box. All analyses were completed within 3 days of sampling. The measured variables included the characteristic water quality parameters following standard procedures (APHA, 1995). Each of the samples was treated separately for the quality parameters. Physical properties analysed were electrical conductivity, total dissolved solids, temperature and turbidity among others. Standard methods and instruments, as recommended by WHO (2006) were used in the determination of the chemical-inorganic parameters.

2.3 Statistical Analysis

Descriptive statistics were applied to determine the mean values of all physico-chemical parameters evaluated. Standard deviations were computed as measures of variance. Duncan multiple range test was used to determine significant differences in mean values among the parameters in the different sites. The level of significance was considered as p-value 0.05.

3.0 RESULTS AND DISCUSSION

The results of the comparative analysis of the physico-chemical properties of the waste water samples from the two study sites are shown in Table 1. The analysis shows that five (5) out of the fifteen (15) physico-chemical properties of the waste water studied were the same across the sites considered. These are temperature, chlorine, zinc, copper and manganese.

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The other parameters were significant at 5% level, implying that their magnitude or concentrations are not the same across the two sites (Minna abattoir and Maizube farm). Therefore, the null hypothesis of equality of mean concentrations is rejected for these significant parameters. Parameters like TDS, EC_w, pH and Fe were significantly higher in Minna abattoir than in Maizube farm, while the reverse was the case for the remaining parameters namely, turbidity, potassium, sodium, magnesium, BOD and COD.

Specifically, the mean levels of total dissolved solid (TDS) from Minna abattoir and Maizube farm were 282.5 ± 10.8 and 218.1 ± 69.3, respectively. This shows that the TDS profile of the waste water from the two sites were significantly different ($p<0.05$). Thus, the TDS concentration level at each site impacted on the irrigation water quality. However, these TDS values fall within the permissible limits of 450 2000 mg/l (FAO, 1985). Elevated TDS can be toxic to aquatic life by causing osmotic stress to the organisms.

Table 1: Analytical results of the physico chemical properties of the waste water at the two study sites.

Parameters	Sample Site Mean (Standard Deviation)		Standard			
	Minna Abattoir	Maizube Farm	FAO	APHA	F	Prob.
TDS	282.5±10.8	218.1±69.3	4502000		5.041	0.049**
EC_w	565.0±21.6	408.3±160.6	0 3000		5.602	0.039**
Temp	28.1±0.65	27.9±1.6	N/A		0.074	0.792
Turb	29.1±.593	0.3±0.95	5*		6.681	0.027**
pH	8.1±	1.66.5± 0.16	6.58.4		6.312	0.031**
CU	36.1±4.63	8.0±11.4		250	0.132	0.724
K	3.7±0.43	5.0±0.26	0-2		41.578	0.000**
Mg	6.9±1.4	9.1±0.89	0-50		9.539	0.010**
Fe	3.1±0.47	2.4±0.30	5.0		9.502	0.012**
Cu	0.02±0.00	0.02±0.00	0.2		0.918	0.360
Zn	0.09±0.03	0.09±0.04	0.2		0.043	0.840
Na	18.8±2.42	7.1±4.2		50	17.123	0.002**
Mn	0.82±0.27	0.51±0.48	0.2		1.764	0.214
BOD	170.5±45.	422 7.5±19.8		25	7.929	0.018**
COD	484.8±6	7.5661.6±5.92		52	4.762	0.001**

* For drinking water quality (WHO, 1986). ** Significant at 5% level of significance.
All parameters are in mg/l except temperature in (°C), turbidity in (NTU), EC_w in (micros/cm) and pH

The electrical conductivities of the waste water samples from the two sites were significantly different ($p<0.05$), and ranged from 408.3 ± 160.6 and 565.0 ± 21.6 micros/cm at Maizube farm and Minna abattoir, respectively. Higher conductivities were observed at Minna abattoir than at Maizube farm. For irrigation purposes, these values do not call for any concern as they fall within the FAO acceptance level for irrigation. The conductivity values obtained in this study are similar to those found in previous studies on waste water effluent (Igbinosa and Okoh, 2009).

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Manganese (Mn) was found to be above the maximum permissible level set by FAO in the two sites. High levels of Mn can be toxic to a number of crops, especially in acid soils (Fipps, 2010). Of all the heavy metals tested, only Fe was significantly different ($p<0.01$) among the two sites. However, the level of all the heavy metals tested (Fe, Cu and Zn) fell within the standard permissible limits. When used in high doses, these metals may accumulate in the soil and impact negatively to plant life. Potassium (K) was highly significant ($p<0.01$) among the treatments in the two sites studied, but was higher in Maizube farm than at the Minna abattoir. This could be ascribed to the additional application of inorganic fertilizer in Maizube farm unlike the local farmers' fields. The K values in both sites were higher than the permissible levels of 2.0 mg/l recommended by FAO.

The turbidity of the waste water samples from the two study sites were statistically different ($p<0.05$). The turbidity values of 29.1 ± 0.59 and 30.0 ± 0.95 NTU recorded at Minna abattoir and Maizube farm, respectively grossly exceeded the WHO standards of 5 NTU for drinking water. However, for surface irrigation, the values may not pose any serious problems. The values of sodium and chloride ions were within the permissible ranges (APHA, 1995). Values of 18.8 ± 2.4 mg/l and 27.1 ± 4.2 mg/l were recorded for sodium ion in Minna abattoir and Maizube farms, respectively; while the concentration of chloride ion in both sources were 36.1 ± 4.6 and 38.0 ± 11.4 mg/l for Minna abattoir and Maizube farms, respectively.

The pH values are generally within the World Health Organization Standard and the FAO pH protection limits of 6.5 to 8.4 for fisheries and aquatic life (Chapman, 1996). The neutral to alkaline pH values obtained in the two suburbs is similar to that reported elsewhere (Morrison et al., 2001).

Qualitative parameters such as BOD and COD examined grossly exceeded the standard levels. The high figures of BOD and COD imply that the waste water at the study sites are highly polluted and may lead to high aerobic activities. Thus, it is advised that pressure sand filter be used at the two study sites to reduce the levels of these parameters in accord with the findings of James (1985) in similar studies.

4.0 CONCLUSION

The results from this study show that the discharge effluent from the two sites exhibited qualities that met acceptable standards appropriate for irrigation without fear of toxicity to crops. However, the level of manganese, which was a little above the acceptable limit could be toxic to some crops, especially in acid soils. Thus, special caution should be exercised when using such waters in acidic soils. Also, qualitative parameters, such as BOD and COD were found to grossly exceed the permissible limits by global standards. Appropriate solution was proffered to forestall such high pollution levels associated with the BOD and COD.

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