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Health hazards of abattoir effluents discharged from the Sokoto central abattoir, Nigeria

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Abstract

This study was undertaken to determine the level of water pollution that can be attributed to effluents discharged from the Sokoto Central abattoir. Both surface and well water samples from the abattoir and adjacent wells were investigated to determine their microbial and physicochemical properties. Samples were collected from five different spots that include; effluents from the abattoir where visceral organs are washed (sample point A), two wells located in the adjacent livestock market (sample point B and C), drainage outside the abattoir (sample point D) and another well downstream the abattoir used for irrigation farming (sample point E). The values for pH, were 7.2, 8.0, 7.5 and 6.8 for all the sampling sites respectively. Similarly, the values of nitrate and BOD recorded were all within the acceptable limit except for point A which had nitrate (60.0 mgl^{-1}) and BOD (26.8 mgl^{-1}) above the acceptable limit. While the total coliforms, for sampling point A and D were found to be very high. There was a significant difference in the quality of water from the studied samples in comparison with the acceptable standard especially with respect to total coliform, BOD, COD, and nitrates. The findings from this study indicate that abattoirs have the potential to contaminate and pollute water sources which may produce a detrimental effect on the quality of groundwater despite the sieving process. Hence, measures should be taken to prevent locating abattoirs in close proximity to human dwellings. Similarly, for the existing ones encroached by human habitation, effective pollution control measures such as treatment of hazardous waste and minimizing the use of chemicals for industrial and agricultural purposes should be taken in order to preserve the quality of groundwater and minimize the potential resultant health effect caused by such contaminants.

Keywords: Abattoir effluents, Health hazards, Sokoto State, Water quality, Waste water

Introduction

Surface and groundwater pollution constitute a severe problem affecting the majority of the developing nations. Traditionally, water pollution is said to occur when unwanted materials enter into the water, thereby changing the quality of the water as well as its physical and chemical attributes, which may produce harmful effects to the environment and human health (Haseena *et al.,* 2017). Substances that commonly pollute water are also frequently toxic to aquatic organisms, especially when they persist in water for long periods thereby exerting chronic effects (Soldán, 2003). Importantly, the risk of the chronic impact of surface and groundwater pollution is very often underestimated due to the less apparent long-time effect (Dellasala *et al.,* 2018). This is because the magnitude of its impact does not manifest acutely or by direct death of affected organisms. For long periods, groundwater is known to be clean and free from contamination. However, due to exponential pollution growth coupled with rapid industrialisation and increased use of chemicals, a large number of contaminants frequently find their way into the groundwater. The significant sources of contamination in groundwater are farming chemicals, septic waste, landfills, uncontrolled hazardous waste, storage tanks, and atmospheric pollutants (Baba & Tayfur, 2011). In addition to these inorganic contaminants, biological pollutants attributable to human and animal wastes which include bacteria, viruses, and parasites that are responsible for waterborne diseases, such as typhoid fever, cholera, and dysentery are common (Dellasala *et al.,* 2018). Similarly, pollution of surface water which is the natural habitat of aquatic animals could produce a consequential impact on man, directly or indirectly since it's the most common source of water for human use both domestic and industrial. Hence, the pollution of surface water in any form is a critical issue in water resource management.

In Nigeria, like most African countries, access to clean and safe drinking water is a constitutional right for all citizens (United Nations, 2014). Unfortunately, sustainable access to a potable water supply for the millions of its citizens is lacking. This has led residents of communities with inadequate water supply to resort to local sources of drinking water mainly from wells, ponds, springs, lakes, rivers, and rainwater in order to meet their domestic water needs (Ado *et al.,* 2015; Edokpayi *et al.,* 2018). Regrettably, water from these sources is often consumed without any form of treatment which constitutes a significant public health risk (Edokpayi *et al.,* 2015). Moreover, available reports indicate that gross contamination of most river bodies across the nation is due to discharge from industrial effluents, sewage, and agricultural wastes among others (Elemile *et al.,* 2019; Omole & Longe, 2008). Contamination of water bodies by abattoir effluents which is the focus of the present study constitutes a significant public and environmental health problem in Nigeria. The meat processing industries produce large volumes of wastewater containing blood, ingesta and solid waste due to the slaughtering of animals and cleaning of the slaughterhouse facilities which sometimes result in environmental pollution (Bustillo & Mehrvar, 2015). Our concern in this investigation is the possible interaction of abattoir waste with underground and surface water supplies. Unfortunately, slaughter activities in Nigeria are characterised by lack of standard operating procedures and good hygiene practice, which pose a risk to public health. Furthermore, due to the absence of water treatment facilities at the abattoir, the discharged effluents may contaminate the environment with pathogens of zoonotic importance. Hence, this study was undertaken to determine the microbiological and physicochemical properties of effluents discharged from the abattoir and the underground water source in order to establish their public health importance.

Materials and Methods

Study area

This investigation was conducted in Sokoto, the capital city of Sokoto State in the Northwestern region of Nigeria. The study location is the Sokoto Central abattoir located in Gandu area, in the outskirt of Sokoto township and is traversed by the River Rima. The state is situated on 12^{o} 15N, and 5^{o} E. Sokoto State is ranked second in terms of livestock population with an estimated number of 3 million cattle, 3.85 million sheep, 4 million goats, 0.8 million camels, and 2 million chickens (Bourn, 1992).

Sample collection and preparation

Five sampling points within and around the Sokoto Central abattoir were identified. These represent drainage points within the abattoir where the effluents exits the abattoir and often used for emptying and cleaning of visceral organs (sampling point A), two wells located in the neighboring livestock market (designated B and C) and two additional points where the drainage from the abattoir empties into the irrigation farm as well as another well in one of the irrigation farm which water is used for farming (these locations are between 20-

50 meters from the abattoir). In each of these sampling points, 50 ml of water sample was collected into a sterile sample bottle, immediately after completion of daily operations. All the samples were transported to the Sokoto State Water Board Laboratory in a black polythene bag for analysis. The dissolved oxygen was determined immediately. Subsequently, the samples were aliquot into different tubes, and samples for Biochemical and Chemical Oxygen Demand (BOD & COD) and stored in a dark environment for five days before the analysis. All the other parameters were analysed soon after collection and transportation to the laboratory.

Analysis of samples

The water samples were analysed to determine the pollution parameters with the acceptable threshold levels. The major pollution parameters that were considered in this study include; water temperature, pH, colour, odour, total dissolved and suspended solids, turbidity, total hardness, compounds of phosphorus, sulphate, iron and nitrate, biochemical oxygen demand, and chemical oxygen demand as well as microbial analysis for total coliform. All the parameters were analysed according to the protocol of the Outreach Department, National Water Resources Institute, Kaduna State, Nigeria. However, the dissolved oxygen and chemical oxygen demand were determined using the Winkler method (Carpenter, 2006).

The turbidity, hardness, nitrate, sulphate, phosphate, chloride and magnesium ion concentrations were among the parameters determined based on the standard laboratory protocols of the Outreach Department, National Water Resources Institute, Kaduna State, Nigeria.

Determination of pH and temperature

The pH was measured using pH meter (Mettler, Tolledo). The electrode was inserted into the water sample to completely immerse the tip of the electrode and the reading was recorded. The temperature of the sample was collected immediately after sampling with the aid of a hand held mercury-in-glass thermometer.

Determination of dissolved oxygen and total dissolved solids (TDS)

About 300 ml of sample, placed in a stoppered bottle, and 2 ml of manganese sulfate and 2 ml of alkali-iodide-azide were added to the water sample. The bottle was then stoppered to avoid trapping air, and the mixture was inverted several times. If there is oxygen in the water, an orange-brown precipitate is formed. The precipitate is dissolved by pipetting 2 ml sulfuric acid before adding sodium thiosulfate. Once the mixture is clear, the acid will be neutralized and the amount of neutralizing sodium thiosulfate used is exactly proportional to the amount of oxygen in the original sample.

The total dissolved solid was determined by filtering a measured volume of sample through a standard glass fiber filter. The filtrate was then added to a pre-weighed dish and then dried in an oven at a temperature of 103^oC. The total dissolved solid was then measured as the total dissolved (filterable) solids.

Determination of total coliform

The multiple-tube fermentation technique was employed to determine the coliform count and the results are statistically expressed in terms of the Most Probable Number (MPN). Briefly, a series of lauryl tryptose broth primary fermentation tubes were inoculated with 2 ml of the sample to be tested and then incubated at 35^oC for 24-48 hrs and the tubes were examined for gas formation.

Results

The result of the Physicochemical and microbial analyses as compared to the WHO standard for water quality is as presented in Table 1. The pH level of the samples from all the five sampling points was within the acceptable limit stipulated by the W.H.O. The result showed that the pH of sampling point A, B, C, and D were all slightly acidic (7.2-8.0) with sampling point E having the least (6.8). The acceptable colour and odour expected for good quality water sample should be colourless and odourless. In the present study, the smell of samples from all the three wells was offensive and colourless. However, samples from point A and E were darkish in colour and produced a very objectionable odour. In this regard, it is essential to note that these offensive smelling samples were from the point where visceral organs are initially washed leaving the ingesta within the drainage and the draining point outside the abattoir where we observed other dirt and human faeces in the stagnant drainage. The score for all other parameters investigated is presented in table 1.

Discussion

Determining the quality of water is an essential component of environmental monitoring. In essence, when water quality is poor, it tends to affect not only aquatic life but the surrounding ecosystem as well. Human activities like farming, pollution, urban growth, sedimentation among others have been

Table 1: Results of the physicochemical and microbial analysis of the water samples

Parameters	Point A	Point B	Point C	Point D	Point E	Reference
pH	7.2	8.0	7.5	8.0	6.8	6.5-8.5
Temperature (°C)	30.5	30.0	30.0	30.0	30.0	<15°C
Total dissolved solid mgl^{-1}	9.8	2.2	1.4	1.2	2.2	1000
Turbidity (NTU)	>1000*	3.1	12.8	1.6	2.2	0.1
Color	Brownish*	Colorless	Colorless	Colorless	Brownish*	Colorless
Total hardness mgl^{-1}	140*	120*	115*	115*	125*	0-75
Calcium mgl^{-1}	86	75	58	65	80	
Magnesium mgl^{-1}	54	45	57	50	45	
Phosphate mg^{-1}	ND	ND	ND	ND	ND	
Sulphate mgl^{-1}	ND	ND	ND	ND	ND	450
Iron mgl^{-1}	4.5*	0.1	0.01	0.01	ND	0.3
Nitrate mgl^{-1}	60.0*	25.0	25.0	5.2	26.0	50
BOD mgl^{-1}	26.8*	2.77	4.3	2.9	3.7	20
COD mgl^{-1}	83.1*	41.8	27.3	30.0	24.6	50
Coliform MPN^{-1}100ml	450	200	200	80	250	0

* indicates levels above WHO standard; ND means Not Detectable

reported to impact significantly on the quality of water (Khatri & Tyagi, 2015). Among these activities, the indiscriminate building of animal slaughter facilities is becoming a severe threat to the environment and present serious health hazards (Elemile *et al.,* 2019). This is not to discountenance the importance of abattoirs which are a vital industry that supplies meat to meet up with protein demands. However, the unregulated nature of citing of abattoirs and slaughter slabs in Nigeria has led to proliferation and location into residential areas which come with a lot of detrimental effects.

In this investigation, results from the microbiological analysis of the different water samples indicated varying levels of contamination with coliforms. The detection of coliforms in all the samples analysed except for the sampling point D (irrigation well) located far away from the abattoir may be due to the proximity of the wells to the abattoir. This is even more so considering that the two highest values were recorded from the samples collected at the point where visceral contents are washed (point A) and the drain outside the abattoir (point E) contaminated by dirt and human faeces. Similarly, the presence of faecal coliform in all the well water sources indicates that they are not fit for human consumption without adequate prior treatment. Exposure to coliform contaminated water has been reported to cause fever, diarrhea and abdominal cramps (Akyala *et al*. 2014). Although, *E. coli* may not generally pose serious threat, other pathogens of faecal origin like Salmonella, and shigella has been known to cause severe invasive infections (Akyala *et al*., 2014). Similarly, assessment of the physical and chemical characteristics of water and effluents was also conducted in order to determine their potential public health implications. The results of this study showed that the highest nitrate, iron, calcium, and magnesium concentration was observed in the sampling point A, where viscera are washed. However, no detectable level of sulfate and phosphate was observed. For nitrate, the high concentration may be due to the high sewage content of the effluents and leaching of nitrate-containing organic wastes that percolate into the wells (Edokpayi *et al.,* 2018). In recent years, nitrate levels in water resources meant for domestic, and agriculture use has increased in many locations largely due to applications of agrochemicals such as fertilizers, pesticides and herbicides and animal manure (Haseena *et al.,* 2017). Furthermore, the biochemical roles of minerals, including magnesium and calcium, in health and disease, are well established. However, the deficiency of a variety of these minerals often leads to the development of many diseases (Kanadhia *et al.*, 2015).

The WHO standard for the temperature of tap water is <15°C (Duressa *et al.*, 2019). In this study, the temperature range was 30.0°C-30.5°C, which is much higher than the WHO limit. The temperature range observed in the present study may not be unconnected with the fact that Sokoto State is located in the tropics with the temperature rising to 45°C during the hot season (Ogunjobi *et al.,* 2018).

Also, similar studies conducted in Ethiopia reported that drinking water temperature higher than the WHO standard (Duressa *et al.,* 2019). On the contrary, the pH of all the water samples in the present study varied from 6.8 to 8.0 without any significant variation across the five sampling points. Based on the acceptable standard, the recommended pH values for drinking water samples should range 6.5–5.5 (WHO, 2017). The result of this investigation was slightly higher than the study conducted in Southwest Nigeria (Ibironke, 2014). Although drinking water with an acidic pH level does not pose a significant health risk, nonetheless associated with aesthetic problems, such as taste, the build-up of scale in water pipes and lowered efficiency of electric water heaters (Islam *et al*., 2017). Factors responsible for fluctuations in water pH include precipitation of especially acid rain and the presence of wastewater or industrial discharges (Hou *et al.,* 2013).

As observed in this study, pollution of water with chemicals and microbes beyond a specific limit is associated with significant environmental and public health hazards. The location of the Sokoto abattoir may equally expose humans, and animals that drink from wells dug close to the abattoir. The situation is common among most of the abattoirs operating in Nigeria, and the potential risks can be exacerbated by the lack of efficient waste management which is prevalent in most Nigerian abattoirs. Assessment of the water quality within the vicinity of abattoirs located close to residential areas as is the case in the study area will help determine the potential risks and anticipated impact on the health of residents as well as their livestock who drink from the shallow wells. To further appreciate the value of such investigations, the Biochemical Oxygen Demand for all the water and effluents sample was determined. Biochemical and Chemical Oxygen Demand (BOD & COD) was the fundamental parameters used to assess the quality of water. They serve as indices to assess the detrimental effect of discharged wastewater on the receiving environment. In the present investigation, the BOD and COD levels of all the water samples tested were below the WHO standard except effluent in sampling point 1 which had 26.8 $mg^{-1}l$ and 83.1 $mg^{-1}l$ as against the recommended levels of 20 $mg^{-1}l$ and 50 $mg^{-1}l$ respectively. BOD and COD indicate the degree of water pollution in terms of bio-degradable waste introduced into the water from effluents and industrial wastes of run-offs. However, it is not surprising considering the fact the sample from point A is rich in organic matter, blood and faecal materials which are a suitable medium for the growth and proliferation of these microbes that utilize the dissolved oxygen that eventually may endanger aquatic life.

In conclusion, the assessment of the physical, chemical and biological parameters conducted in the present study is to determine the quality of the water samples and in a way establish their potential to cause environmental and health hazards to humans and animals. The study reveals that the quality of water from the two wells within the livestock market (Kara market) was not suitable for consumption due to the presence of coliforms, however, samples from the effluents and the last well-located downs stream showed much higher levels of impurities that may produce health problems particularly the well water that is often used in irrigation farming. Finally, it is essential to note that not all of the chemicals with guideline values are found at levels that pose health risks. Equally, some detrimental chemicals not capture by the established guideline may nevertheless be of legitimate local concern under certain circumstances. Hence, risk management strategies should be geared towards those chemicals that pose a risk to human and animal health as well as those parameters that impact significantly on the acceptability of water.

We acknowledge that lack of control sample (water sample outside the study location) as a limitation for the present study. Nonetheless, the study was able to demonstrate the potential hazards associated with seepage of effluents into underground water source.

Conflicts of Interest

The authors declare no conflict of interest.

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