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Effect Of Abattoir Waste Water On Adjoining Stream (Ado-Ekiti, Nigeria As A Case Study)

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ABSTRACT

A large percentage of people in Nigeria still depend on streams for domestic water supply including drinking. However, this source of water has been known to be polluted in one way or the other. One of the major pollutants is water discharged from abattoirs directly into the stream. Consequently, this paper highlights the effects of these wastes on the quality of water from adjoining streams. Four different abattoirs were selected at each geographical zone of Ado Ekiti (Lat.$7^0 37' 00''$N, Long. $5^0 13' 00''$E) Southwestern Nigeria, as a case study. Water samples were subjected to physical, chemical and biological examination to verify conformity to World Health Organisation (WHO) standards. Physical quality parameters tested were Temperature, Odour, Colour, Appearance and Total Solids. Chemical quality parameters tested were Bi-carbonate, Nitrate, Phosphate, Chloride and Ammonia content, Total Hardness, Chemical Oxygen Demand (COD) and Dissolved Oxygen (DO). Bio-chemical Oxygen Demand (BOD) and Bacteriological plate count tests were also carried out. Results show that none of the samples tested was within the WHO standard in terms of the quality of drinkable water. It was recommended that all unreliable water sources be well treated before they are used for domestic purposes to forestall outbreak of water borne diseases in the area covered.

Keywords: Wastewater, Physical, Chemical and Biological Quality Parameters

INTRODUCTION

Water is very useful for domestic and industrial purposes. Apart from drinking, it is also used for cleaning. The use of water for cleaning is prominent in abattoirs where it is generally applied to clean tables and other materials employed during the slaughtering of animals and floor to take care of animal waste such as blood, feaces and others. Abattoir wastewater is characterized by the presence of high concentration of the whole blood of the slaughtered animals and suspended particles of semi-digested and undigested feeds within the stomach and intestine of slaughtered animals. Since slaughtering and dressing of food animals take place in an abattoir, it becomes easier to refer to the wastewater from this industrial system as abattoir wastewater (Coker *et al*, 2001).

However, it has been discovered that some abattoirs are deliberately located close to streams and their waste water are discharged into them. These streams serve the immediate community of people when they are fetched and used directly for cooking, washing and in some cases as drinking water. But recent publications show that zoonotic diseases (diseases of animals that are transmissible to humans and vice versa) are yet to be eliminated or fully controlled in over 80% of the public abattoirs in Nigeria (Adeyemo, 2002)

The aim of this study is to report the results of a study done to find the effects of abattoir waste water on adjoining streams in Ado Ekiti metropolis.

METHODOLOGY

Water samples were taken from four different adjoining rivers to abattoirs at the following geological zones of Ado Ekiti: Falegan, Basiri, Ajilosun and Atikankan (which will henceforth be referred to as streams 1, 2, 3, and 4 respectively). From each of these locations, three samples were collected before the abattoir source pollution, at the abattoir source pollution and after the abattoir source pollution. Sample temperatures were taken at the point of sample collection and in the laboratory to record any differences that may affect the tests to be carried out in the laboratory. Fig. 1 shows the illustration of the abattoir water discharge into the streams.

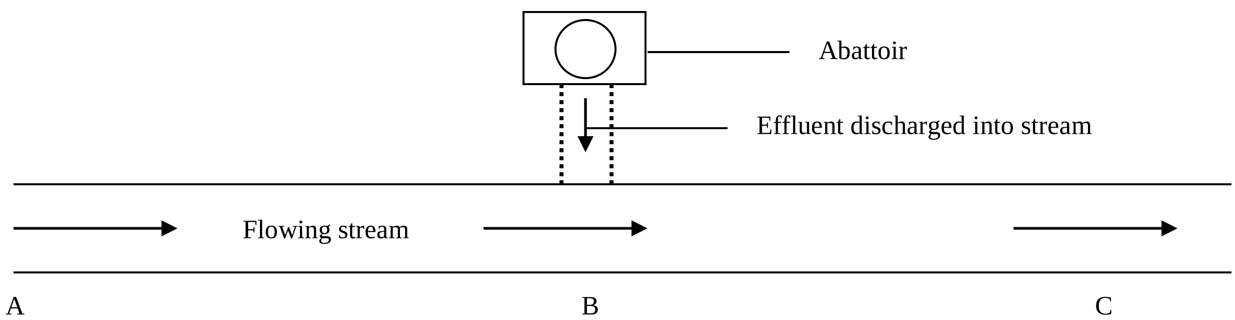

Fig. 1: Illustration of abattoir waste water discharge into stream

A = Point of collection of water sample before abattoir

B = Point of collection of water sample at abattoir source

C = Point of collection of water sample after abattoir

The tests carried out in the laboratory were Physical, Chemical and Bacteriological.

Physical Tests

Temperature of different abattoir locations was determined with mercury thermometer and digital thermometer. The density, viscosity of water, the solubility and diffusivity of gas in water are dependent upon water temperature. Mercury thermometer was used on site by placing it vertically in the sample with the bulb fully suspended in it and is allowed to stand until the values were recorded and the results are shown in Table 1.

Odour was determined by human perception as Odourless, Rotten Egg smell, H_2S smell, or pungent smell.

Colour was known by dertermining the Hazen unit values for water samples. 10ml of the water samples were measured into test tubes. The samples were then examined using the Hazen with lovibond scale. The results are shown in Table 1.

Appearance test was carried out by filling test tubes with water samples. The test tubes were shaken vigorously. The general characteristics are stated in Table 1.

Chemical Tests

Nitrate checkit was used to check for nitrate. One nitrate tablet and one level spoonful nitrate test powder was added to 20ml sample in a nitrate tube. The mixture was shaken for one minute and left to settle. 10ml solution was decanted into nitrate checkit and one nitrocol tablet and shaken for homogeneity. The solution was allowed to stand for 10 minutes. It was then given a final shaking and the colour was compared against the standard colour during daylight.

Ammonia checkit was used to check for ammonia. The stopper was removed and the three compartment of the checkit was rinsed with the water sample and filled to 10ml mark. The center compartment was also filled to compensate for any inherent colour or turbidity present in the sample. Ammonia tablets were crushed and added to the compartments and the stopper was replaced. The stopper was held firmly and the checkit was inverted until the tablets were fully dissolved. The checkit was allowed to stand for 10 minutes and a final shaking was done. The colour produced was checked against the standard and the nearest colour match was selected.

Phosphate checkit was used in similar manner as Nitrate and Ammonia. The results obtained are shown in Table 2.

The results of Total Hardness, Chemical Oxygen Demand (COD) and Dissolved Oxygen (DO) are also shown in Table 2.

Bacteriological Impurities Test

Coliform Plate Count Test

15g of EMB agar was weighed and dissolved in 50ml of distilled water and transferred into a 500ml conical flask. The mouth was covered with cotton wool and aluminium foil and placed in the autoclave for 15minutes at 120 ^{0}C. Molten EMB Agar was poured into petri dish, placed on the table and cleaned with ethanol to prevent contamination. The plates were then cooled to 48^{0}C and allowed to solidify. Planting of organisms from each of the water samples was done by streaking sterilized loop on the spirit flame on the surface of the Agar plate. The plates were labeled and kept in the incubator at 37 for 48 hours. The bacteria colonies which grew on the plates were then counted with colony counter. The number of colonies per ml of the original samples were obtained by multiplying the number of colonies per plate by the dilution factor. Count are usually taken between 30 and 300. Equation 1 was used to estimate the viable counts per ml of original sample.

$$n = \frac{X \times Df}{0.05} \qquad (1)$$

Where n = viable count per ml of original shapes

X= mean of the number of counts

Df= dilution factor

Test for E.Coli

Grain-stained procedure was carried out. The inoculums which were transferred from the plate when stained and the characteristic colonies such as colony, size, pigment, elevation produced were used for the qualitative description of gram positive or gram negative. The appearance of *Escherischa coli* and *feacal streptococci* were recorded. Results are presented in Table 3.

Bio-chemical Oxygen Demand (BOD)

This is the amount of oxygen (in mg/L) needed by aerobic micro-organisms over a period to oxidise organic material in water (and break it down into harmless products) (Thomas, 2014). Bio-chemical Oxygen Demand is used as a measure of the quantity of oxygen required for oxidation of biodegradable organic matter present in water by aerobic biochemical action. BOD is the most commonly used method to determine waste loading requirement for effluent treatment plant. 150 ml of waste water plus 100 ml of dilution water was measured into each BOD bottle. The initial value of dissolved oxygen was determined after the BOD instrument had been placed in the thermometer chamber of the incubator at 20^0C. A comparism of the oxygen content of the sample at the beginning and end of the incubation is the measure of BOD depending on the dilution factor which in this case is calculated as 1.7%. Table 4.0 shows the results of Biochemical Oxygen Demand (BOD) test on water samples at 1.7 dilution factor.

RESULTS

Results of the physical, chemical and biological tests are as presented in Tables 1 – 4. Table 5 shows WHO surface water quality classification of Biochemical Oxygen Demand (BOD)

Table 1: Comparative physical test results of water samples with WHO standards

Physical Parameter	Streams	Water sample's conformity status with WHO standards			Percentage conformity for each stream (%)	WHO Standard	Remark
		Before Source	At Source	After Source			
Temperature (^oC)	Stream 1	23.1 ^oC	23.2 ^oC	23.2 ^oC	0	10 – 15.5 ^oC	0% Conformity
	Stream 2	23.0 ^oC	23.3^oC	23.2 ^oC	0		
	Stream 3	23.0 ^oC	23.2 ^oC	23.1 ^oC	0		
	Stream 4	23.2 ^oC	23.0 ^oC	23.1 ^oC	0		
Odour	Stream 1	Odourless	Rotten Egg	H_2S Smell	0	Virtually Absent	0% Conformity
	Stream 2	Odourless	Rotten Egg	Rotten Egg	0		
	Stream 3	Odourless	Rotten Egg	H_2S Smell	0		
	Stream 4	Odourless	Rotten Egg	Pungent	0		
Colour (Hu)	Stream 1	15	80	40	66.7	5 – 50 Hazin Unit	41.7% Conformity
	Stream 2	5	90	100	0		
	Stream 3	10	80	40	66.7		
	Stream 4	10	100	80	33.3		
Appearance	Stream 1	Clear, not clean	Light Brown	Dark Brown	0	Virtually Absent	0% Conformity
	Stream 2	Clear, not clean	Dark Brown	Blackish	0		
	Stream 3	Clear, not clean	Dark Brown	Light Brown	0		
	Stream 4	Not Clear	Dark Brown	Dark Brown	0		
Total Solids	Stream 1	1000	2000	2000	33.3	500 - 1500	33.3% Conformity
	Stream 2	1000	12000	4000	33.3		
	Stream 3	1000	10000	2000	33.3		
	Stream 4	1000	24000	5000	33.3		

Table 2. Comparative chemical test results of water samples with WHO standards

Chemical Parameter	Streams	Water sample's conformity status with WHO standards			Percentage conformity for each stream (%)	Remark
		Before Source	At Source	After Source		
Bi-Carbonate (mg/L)	Stream 1	X	X	X	0	0% Conformity
	Stream 2	X	X	X	0	
	Stream 3	X	X	X	0	
	Stream 4	X	X	X	0	
PH (mg/L)	Stream 1	X	X	X	0	8.3% Conformity
	Stream 2	X	X	X	0	
	Stream 3	X	X	X	0	
	Stream 4	X	✓	X	33.3	
Nitrate (mg/L)	Stream 1	X	X	X	0	0% Conformity
	Stream 2	X	X	X	0	
	Stream 3	X	X	X	0	
	Stream 4	X	X	X	0	
Phosphate (mg/L)	Stream 1	✓	X	X	33.3	33.3% Conformity
	Stream 2	✓	X	X	33.3	
	Stream 3	✓	X	X	33.3	
	Stream 4	✓	X	X	33.3	
Chloride (mg/L)	Stream 1	✓	✓	✓	100	66.7% Conformity
	Stream 2	✓	✓	✓	100	
	Stream 3	✓	✓	X	66.7	
	Stream 4	X	X	X	0	
Ammonia (mg/L)	Stream 1	X	X	X	0	0% Conformity
	Stream 2	X	X	X	0	
	Stream 3	X	X	X	0	
	Stream 4	X	X	X	0	
Total Hardness (mg/L)	Stream 1	X	X	X	0	58.3% Conformity
	Stream 2	X	✓	✓	66.7	
	Stream 3	X	✓	✓	66.7	
	Stream 4	✓	✓	✓	100	
COD (mg/L)	Stream 1	X	X	X	0	0% Conformity
	Stream 2	X	X	X	0	
	Stream 3	X	X	X	0	
	Stream 4	X	X	X	0	
Dissolved Oxygen (mg/L)	Stream 1	X	X	X	0	0% Conformity
	Stream 2	X	X	X	0	
	Stream 3	X	X	X	0	
	Stream 4	X	X	X	0	

Table 3: Comparative results of plate count (Agar Test) with WHO standards

Water Sample	Coliform count (cfu x 10^5 per 100ml)	E.Coli (Positive/Negative)	Colonies (x 10^5)	Plate count remark
Sream 1				
Before source	9	Positive	1.5	Unsatisfactory
At source	6	Positive	1.0	Unsatisfactory
After Source	4	Positive	6.7	Unsatisfactory
Stream 2				
Before source	5	Positive	8.3	Unsatisfactory
At source	14	Positive	2.3	Unsatisfactory
After source	20	Positive	3.3	Unsatisfactory
Stream 3				
Before source	6	Positive	1.0	Unsatisfactory
At source	17	Positive	2.8	Unsatisfactory
After source	12	Positive	2.0	Unsatisfactory
Stream 4				
Before source	2	Positive	3.3	Unsatisfactory
At source	42	Positive	7.0	Unsatisfactory
After source	9	Positive	1.5	Unsatisfactory

WHO Bacteria Standard on Drinking

- Throughout any year, 95% of samples should not contain any coliform organism in 100 ml.
- No sample should contain more than 10 coliform organism per 100 ml.
- Coliform organism should not be detectable in 100 ml of any consecutive samples (WHO, 2006)

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Table 4 : Results of Biochemical Oxygen Demand (BOD) test on water samples at 1.7 dilution factor

Water sample	Dissolved Oxygen (DO) (ppm)		Biochemical Oxygen Demand (BOD) (mg/l)		Calculated $BOD_5 = \frac{DO_5 - DO_1}{1.7}$
	Day 1	**Day 5**	**BOD $_1$**	**BOD $_5$**	
Stream 1					
Before source	1.52	9.10	300.00	30.00	4.46
At source	0.94	8.85	400.00	40.00	4.65
After source	0.95	8.97	1100.00	110.00	4.72
Stream 2					
Before source	1.04	9.64	200.00	20.00	5.06
At source	0.56	9.89	300.00	30.00	5.49
After source	0.53	9.50	200.00	20.00	5.28
Stream 3					
Before source	1.02	9.04	300.00	30.00	4.72
At source	0.48	8.58	1000.00	100.00	4.77
After source	0.49	8.74	700.00	70.00	4.85
Stream 4					
Before source	0.97	9.50	200.00	20.00	5.02
At source	0.93	9.27	300.00	30.00	4.91
After source	0.92	9.41	720.00	72.00	4.99

Table 5 : WHO Surface water quality classification of Biochemical Oxygen Demand (BOD)

Excellent	Acceptable	Slightly polluted	Heavily polluted
Less than 3.0	3.0- 5.9mg/l	6.0 – 11.9 mg/l	12.0 mg/l and above

DISCUSSION

The results obtained from the laboratory show that the physical parameters of the streams under study increased through the abattoirs and reduced with distance depending on the initial concentration of the waste at the point of discharge. Also all the results were not in conformity with World Health Organisation (WHO) standards. Results of chemical parameters also show that the streams were heavily polluted and as such are not fit for human consumption and other uses if they are not treated.

CONCLUSION

This study shows that majority of the abattoirs in the area under study were deliberately sited close to streams so that wastes can be easily disposed off by discharging them into such streams. It was established that the streams were used as the major source of domestic water supply which therefore exposes the inhabitants in the area to potential health hazards. Results of water samples taken for physical, chemical and biological examination show non conformity with WHO standards for safe drinking water. The large presence of *E. Coli* is particularly disturbing as it may trigger a serious disease outbreak which may be difficult to quickly contain. It is therefore recommended that adequate and intensive treatment must be given to water in this area and abattoir wastewater should not be directly discharged into streams.

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