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# The Effect of Minna Abattoir Waste on Surface Water Quality I

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**Abstract:** Abattoir waste can have adverse environmental effects on water quality if the waste is directed towards a river or stream. This study is therefore, aimed at evaluating the effects of Minna abattoir wastes on the receiving stream by analyzing the physical and chemical parameters of water samples taken at 3 different sites: Upstream (US), at the point where, the abattoir waste meets with the stream (PS) and Downstream (DS) during the wet season of 2006. The results of the water analyses showed the various ranges of values obtained as follows: turbidity (43.0, 58.0 and 55.0 FTU), odour (odourless, offensive and slight odour), iron content (0.91, 0.52 and 0.55 mg $L^{-1}$), total alkalinity (164.0, 104.0 and 90 mg $L^{-1}$) and pH values were 6.8, 8.8 and 6.8 for US, PS and DS, respectively. These values are at variance with the allowable limits of the World Health Organization (WHO) for drinking water. The results showed that the abattoir effluent has lowered the quality of the receiving Tayi stream.

**Key words:** Abattoir waste, effluent, pollution, stream, surface water, wastewater

## INTRODUCTION

Livestock production, which is perceived by the public to be potential food for the world's needy people, is a major pollutant of the countryside (where, the animals are raised) and cities, if processors do not manage slaughter wastes properly with dung and slurry washed into waterways. Other environmental problems include pollution of soil with dung and the atmosphere with methane (a greenhouse gas) from decomposing wastes.

An abattoir has been defined as a premise approved and registered by the controlling authority for hygienic slaughtering and inspection of animals, processing and effective preservation and storage of meat products for human consumption (Alonge, 1991). Livestock waste spills can introduce enteric pathogens and excess nutrients into surface wasters (Meadows, 1995). The wastes from Abattoir operations can be separated into solid, liquid and fat. These wastes are highly organic. The solid waste includes condensed meat, undigested ingests, bones, horns, hairs and aborted fetuses. The liquid waste is usually composed of dissolved solids, blood, gut contents, urine and water, while fat waste consists of fat/oil.

Pollution of our water resources might lead to destruction of primary producers and this in turn leads to diminishing consumer populations in water. The direct repercussion of this is diminishing fish yield with the resultant consequence that human diet suffers. Such conditions may arise through careless discharge of dangerous slowly biodegradable and non-biodegradable wastes e.g., pesticides. The use of detergent that contains phosphorous may lead to eutrophication of inland lakes or dams. Anaerobic conditions may arise and this will make it difficult for aquatic life to flourish. Incidentally, survival of aquatic life is one very important tool for water quality monitoring. In terms of biological indication of water quality, use is made of aquatic lives (e.g., Diphniamagna) which are very sensitive to changes in pressure, pH, dissolved oxygen, toxicity and other chemical changes in water. These organisms may become disfigured or their reproductive lives impaired or are killed (Aina and Adedipe, 1991).

In essence, slaughter activities, if not properly controlled, may pose dangers to the farmers, butchers, the environment as well as the consumers. Abattoir effluent reaching streams may contribute significant levels of nitrogen, phosphorus and biochemical oxygen demand and other nutrients, thereby resulting in stream pollution. These effluents would reduce stream physical and chemical qualities; more so, pathogens from cattle waste could be transmitted to humans recreating in such streams. These are some of the main reasons that led to the analysis of waste from Minna abattoir. Information obtained from the study can be used to design efficient end-use treatment and mitigation measures towards the

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impact of wastes on our environment. The study is aimed at carrying out qualitative analysis of water samples from the stream around Minna abattoir and studying the effects of the wastes on the receiving stream.

## MATERIALS AND METHODS

**Description of Minna Abattoir:** Minna town, the state capital of Niger state lies on latitude 9°3'N and longitude 6°3'E. The abattoir is located in an area popularly known as Tayi Village, along Bosso Road, Minna. It is constructed in such a way to accommodate 3-4 slaughtering. The abattoir is divided into 3 main sections namely, the slaughtering section, the processing section (skin and bone removal/skin burning) and the waste dumping site.

**The slaughtering section:** The animals are first checked by a veterinary doctor for any infections. If the animals are certified free of any infection they are kept in a place called the waiting site after which it will be brought into the slaughtering section for slaughtering. The animals are slaughtered on the floor by a staff. The blood with any other liquid that comes out of the animal passes through a channel, which leads to a reservoir outside the building. As of the time of this research, the reservoir constructed with concrete has been destroyed, thus, the wastes from the building are channeled directly into the Tayi stream.

**The processing and dumping sections:** The processing section is where, the slaughtered animals are skinned or sometimes the skin is burnt, bones and internal parts of the animals are removed, washed and chopped into portions. The blood with any other liquid that comes out during the slaughtering as well as faecal waste from the animal intestines passes through the centralized channel, which leads to Tayi stream. These are liquid and suspended solid wastes. The bones which are solid waste are usually dumped into the dumping section and burnt before they are sold.

**Collection of water samples and method of analysis:** Samples of water from Tayi stream in the vicinity of Minna abattoir were taken at 3 different points using three thoroughly washed 0.50 L plastic containers. The plastic bottles were well covered to protect them from contamination and were immediately taken to the laboratory for analysis. The collected samples were designated as follows:

Upstream (US) sample collected 60 m before the point where, the abattoir waste meets the stream; PS-sample collected at the point where, the abattoir waste meets with the stream and Downstream (DS) sample collected 60 m away from the point where, the abattoir waste meets with the stream. Standard laboratory reagents and apparatuses were used to analyze the water samples into physical, chemical and organic parameters. The method and procedure of the analysis were those described by the APHA (1995, 2000).

## RESULTS AND DISCUSSION

The physical parameters of the water samples analysed are presented in Table 1.

### Physical parameters of the samples

**Electrical conductivity:** The electrical conductivity of the samples ranged from 100-180 $\mu s\ cm^{-1}$ (Table 1). Sample US (upstream) has the lowest electrical conductivity of 100 $\mu s\ cm^{-1}$ and sample PS (where, the abattoir waste meets with Tayi stream) had the highest electrical conductivity of 180 $\mu s\ cm^{-1}$. Sixty metres downstream the electrical conductivity was 150 $\mu s\ cm^{-1}$. Therefore, there is a build up of electrical conductivity at the point the waste enters the stream. These values are well outside the limit of 3.0 $\mu s\ cm^{-1}$ recommended by FAO for water used for agricultural purposes such as irrigation (Chukwu, 2005). One of the important criteria usually used to assess the irrigation water quality is total concentration of dissolved solids/salts and is expressed in terms of electrical conductivity.

**Total dissolved solids:** The total dissolved solids (TDS) of the samples were quite high when compared to WHO (2004), maximum allowable value of 500 mg $L^{-1}$. However, the values are within the allowable limit of FEPA (1991), which is 2000 mg $L^{-1}$. From Table 1, however, it shows that the effluents from the abattoir have a dilution effect on TDS as there is a progressive decrease from the upstream section through the point the effluents enter into the stream to the downstream section.

**Temperature:** The temperatures of the samples at US and PS sections were higher than the WHO (2004), recommended standards but were within FEPA (1991), values of 35-40°C. High temperatures cause thermal pollution and adversely affect aquatic life. One of the effects of raising water temperature is that it lowers the viscosity of the water and so causes faster settling of solid particles. An increase of temperature also causes a decrease in the solubility of oxygen, which is needed for oxidation of biodegradable wastes. At the same time, the rate of oxidation is accelerated, imposing a faster oxygen

Table 1: Physical parameters of the samples

| Parameter | US | PS | DS | FEPA* | WHO+ |
|---|---|---|---|---|---|
| Electrical conductivity (μs $cm^{-1}$) | 100 | 180 | 150 | N/A | N/A |
| Total dissolved solids (mg $L^{-1}$) | 1050 | 990 | 700 | 2000 | 500 |
| Temperature (°C) | 32.0 | 30.0 | 27.0 | 35-40 | 29 |
| ph | 6.8 | 8.8 | 6.8 | 6-9 | 6.5-8.5 |
| Odour | Odourless | Offensive | Little odour | N/A | Inoffensive |
| Total suspended solids (mg $L^{-1}$) | 1030 | 915 | 712 | 30 | N/A |
| Turbidity (FTU) | 43 | 58 | 55 | <10 | 5 |

FTU: Formazin Turbidity Units; N/A = Not Available; *Maximum Allowable Level (FEPA, 1991); +Maximum Allowable Level (WHO, 2004)

demand on the smaller supply and thereby depleting the oxygen content of the water further. Temperature also affects the lower organisms in the aquatic food chain, such as plankton and crustaceans. In general, the higher the temperature, the less desirable are the types of algae in water. In cooler waters diatoms are the predominant phytoplankton in water that is heavily eutrophic. With the same nutrient levels, green algae begin to become dominant at higher water temperatures and diatoms decline, while at the highest water temperatures, blue-green algae thrive and often develop into heavy blooms. Many pathogenic bacteria thrive when the temperatures of some streams are slightly increased and their abundance can be very harmful to fish. A difficulty also arises because the deleterious effects of a temperature increase on fish are synergistic with the effects of sewage, toxic chemicals and perhaps other pollutants (Chukwu, 2005).

**Odour:** Sample US was odourless, while samples PS and DS had offensive and little odour, respectively. This may probably be due to the direct influence of the abattoir waste on the samples especially as putrefaction of the organic components of the waste takes place at the point of discharge into the stream. The intensity of the odour reported also depends on the period the samples were collected.

**pH:** The pH values of the samples ranged from 6.8-8.8. This is quite within the acceptable limits (FEPA, 1991). However, the pH of 8.8 recorded for sample PS was above WHO (2004), maximum allowable level. This could lead to eutrophication or nutrient enrichment with its attendant disastrous consequences. For example, the addition of inorganic or organic matter into a body of water can have a devastating effect on a pond or a lake. Although, these materials tend to have the same kind of oxygen-consuming effect on rivers, the impact there can be quite variable. Rivers vary considerably in flow and consequently, they have different rates of re-oxygenation, mixing and sediment load, which limit penetration of sunlight (consequently, plant growth). These factors all determine the impact of eutrophicants (Modak and Biswas, 1999; Chukwu, 2005).

**Total Suspended Solids (TSS):** The values for the TSS are 1030, 915 and 712 mg $L^{-1}$ for the US, PS and DS sections of the stream, respectively. This shows that the TSS for the 3 samples far exceeds the value recommended by FEPA which is 30 mg $L^{-1}$. However, this unacceptable condition may not be attributed to the abattoir waste directly since, the TSS for the upstream section when the waste has not come in contact with the stream far exceeds that at the PS and DS sections. The waste itself appears to have a dilution effect since, the TSS at the meeting point between waste and stream is less than that at the upstream section and even further decreased at the downstream section.

In general, suspended load may be considered a pollutant when it exceeds natural concentrations and has a detrimental effect on water quality in its biologic and aesthetic sense. The total suspended solids for the effluent from the abattoir violate the permissible limit by FEPA. In their present concentration, they could contribute to high turbidity of the receiving water body. Increase in turbidity can be considered a type of pollution in that it affects the biotic balance (Chukwu, 2005). Turbidity increases with, but not as fast as, suspended-load concentration. Typical relations between them are given by Emmet (1975) as:

$$t = cG_c^n$$

Where:

- t = Turbidity in Jackson Turbidity Units.
- $G_c$ = Suspended-sediment concentration.
- c = Coefficient varying between 0.7 and 1.3.
- n = An exponent between 0.6 and 0.7.

**Turbidity:** Turbidity is an expression of the optical property of water that scatters light. The turbidity values recorded for all the samples were higher than the FEPA (1991) and WHO (2004), recommended limits of <10 and 5 FTU for drinking water, respectively. This shows that the abattoir effluent contributed a lot to the pollution of the stream especially as the highest value of 58 FTU was recorded at the point the effluent meets the stream.

High turbidity level leads to high level of deposition downstream and silt problems in the water where, the waste is discharged. This could cause blockage of drain passages due to deposition that could cause flooding. If the water is used for irrigation, the suspended matter could block the soil pore spaces leading to poor drainage and increased runoff resulting to flooding and possible erosion problem. In addition, if such water is to be recycled, it increases the cost of water treatment (Chukwu, 2005).

High turbidity also adversely affects the aquatic life by preventing adequate penetration of sunlight into bodies of water. Sunlight is needed by sea weeds for photosynthetic activities. It also leads to blocking of the gills of the fishes, making the aquatic life population in the river to reduce. In addition, visibility of aquatic lives is impaired at high turbidity levels. However, decreased turbidity beyond a certain level is not good in itself. This is because decreased turbidity promotes the growth of algae. Whereas, this increase in photosynthesis increases the dissolved oxygen during sunlight hours, the large amount of organic material tends to reduce greatly, the available dissolved oxygen during hours of darkness. Hence, it can be seen that merely reducing turbidity does not necessarily solve problems, but may create a new one (Chukwu, 2005).

**Chemical parameters of the samples:** The chemical parameters of the water samples analyzed are presented in Table 2.

The values for most of the chemical parameters were relatively low when compared with the tolerance limits allowed by both FEPA and WHO. The Iron contents were higher than, the WHO (2004), recommended level of 0.30 mg $L^{-1}$. This may likely be related to blood from the slaughtered animals entering the streams and may also be due to the period of sample collection. The calcium content at the US section was higher than the FEPA recommended limit of 200 mg $L^{-1}$. The magnesium contents at the 3 sections all exceeded the recommended

Table 2: Chemical parameters of the samples

| Parameter (mg $L^{-1}$) | US | PS | DS | FEPA* | WHO+ |
|---|---|---|---|---|---|
| Total hardness | 21 | 41 | 32 | N/A | N/A |
| Total alkalinity | 164 | 104 | 90 | N/A | N/A |
| Hardness (Ca) as $CaCO_3$ | 8.4 | 16.4 | 12.8 | N/A | 500 |
| Hardness (Mg) as $MgCO_3$ | 12.6 | 24.6 | 19.2 | N/A | N/A |
| Iron content | 0.91 | 0.52 | 0.52 | <1 | 0.30 |
| Nitrate as Nitrogen | 1.5 | 2.2 | 2.0 | N/A | 10 |
| Nitrate | 6.6 | 9.68 | 8.8 | 10 | 10 |
| Sulphate | 10 | 9 | 4 | 500 | 250 |
| Phosphate | 2.42 | 1.99 | 0.86 | 5 | N/A |
| Calcium | 233.36 | 86.56 | 55.12 | 200 | N/A |
| Magnesium | 333.06 | 255.98 | 214.67 | 200 | 30 |
| Nitrite | 0.073 | 0.205 | 0.512 | N/A | 1 |
| Nitrite as Nitrogen | 0.022 | 0.062 | 0.046 | N/A | N/A |
| Nickel | 0.00 | 0.030 | 0.00 | N/A | 0.001 |
| Copper | 0.00 | 0.01 | 0.00 | 1.5 | 1.0 |

* Maximum Allowable Level (FEPA, 1991); + Maximum Allowable Level (WHO, 1983, 2004); N/A = Not Available

limits by both FEPA and WHO. The Nickel content at the point where, the abattoir waste enters the stream is higher than the recommended limit by WHO (2004).

In the case of sulphate, effluents are allowed by FEPA to be used for irrigation purposes if the sulphate content is = 500 mg $L^{-1}$. The result satisfies the criterion for use of the effluent from the abattoir as irrigation water. Furthermore, Sulphur is quite important to plants as it helps in the formation of certain proteins in the protoplasm and it is always found in the sulphates.

Reactive phosphate in the effluent has values that range between 0.86 and 2.42 mg $L^{-1}$. The values are within the maximum allowable level by FEPA which is 5 mg $L^{-1}$. They do not however, satisfy the desirable level of 0.5 mg $L^{-1}$ for drinking water as recommended by WHO (1979). The effluent from the abattoir does not satisfy any of the above standards and has to be reinforced with phosphorus concentrates/tablets if it is to be used for irrigation or treated for use as drinking water. Phosphate which is the source of phosphorus in the soil helps in formation of nucleoproteins and coenzymes. It also aids nuclear division in plant cells (Chukwu, 2005; Chukwu *et al*., 2007).

Total iron from the effluent is between 0.52 and 0.91 mg $L^{-1}$ and it is within the recommended level of <1 mg $L^{-1}$ by FEPA. However, WHO recommended a level of 0.3 mg $L^{-1}$, if the water is to be used for drinking purposes so the effluent from the abattoir does not satisfy this condition. This implies that if the abattoir discharges its wastewater into other bodies of water used for drinking purposes downstream, it could be a contaminant and hence, hazardous to human health. The presence of excess iron in water imparts taste, reddish colour (which may stain laundry, fountains and plumbing fixtures) and it also increases the turbidity of the water. The effects of turbidity on aquatic organisms have been discussed elsewhere. It in addition promotes, the growth of iron bacteria that hasten rusting process of all the ferrous metals that come in contact with the water.

Copper concentration in the discharge was found to be between 0.0 and 0.01 mg $L^{-1}$, which is within the limit specified by FEPA (1.5 mg $L^{-1}$). Copper in excess could impart a bitter taste to water and it is toxic to fish. In addition, it promotes the corrosion of galvanized iron and steel fittings.

Nitrate level of the effluent ranges between 6.60 and 9.68 mg $L^{-1}$, which is an acceptable level according to FEPA (10 mg $L^{-1}$) and WHO (10 mg $L^{-1}$). The value of 9.68 mg $L^{-1}$ was got at the point where, the abattoir waste meets the Tayi stream. This is on the high side. Excess nitrate in water used for irrigation causes lodging of plants, delays ripening and increases susceptibility of plants to pests and diseases due to over luxuriant vegetative growth. Consequently, if the liquid effluent is applied to soil for irrigation, it could lead to loss of yield in crop production. Nitrogen in the form of nitrates is needed by plants for synthesis of amino acids, proteins, nitrogenous bases and chlorophyll (Chukwu, 2005).

Nitrite is the first product of oxidation of ammonia by biochemical activities. The level is between 0.022 and 0.062 mg $L^{-1}$. Although, FEPA and WHO did not specify the acceptable levels, according to EPA (1992), a value above 0.001 mg $L^{-1}$ is of sanitary significance and any value above 1.0 mg $L^{-1}$ is hazardous in drinking water particularly for infants. The significance is that the effluents are not safe to be discharged into any stream that could be used for drinking without further treatment to reduce/remove nitrite content (Chukwu *et al*., 2007).

## CONCLUSION

The aim of evaluating the effect of abattoir waste on surface water was achieved by analyzing the physical, chemical and organic parameters of water samples at various locations within and around the abattoir. Also, the high change in colour of the stream reduces the quality of the water thereby making it unfit for drinking and bathing. Using FEPA and WHO recommended limits as bases for comparison, it therefore, implies that Minna abattoir effluent has lowered the quality of receiving stream and that they contain several pollutants which are above the allowable limits. It was then recommended that further discharge of the abattoir effluent into Tayi stream should be stopped.

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