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Assessment of underground water quality parameters of an abandoned abattoir

Musa J.J[a]*, M. Saidu[b] and M.S. Hussaini[c]

[a]*Department of Agricultural and Bioresources Engineering, Federal University of Technology P.M.B. 65, Minna, Nigeria*

[b]*Department of Civil Engineering, Federal University of Technology, P.M.B. 65, Minna, Nigeria*

[c]*Department of Agricultural and Bio-environmental Engineering, Federal Polytechnic, P.M.B. 35, Mubi, Nigeria*

**Corresponding author: jogric2000@yahoo.com; Phone: +2348036682747*

Abstract

The objective of this study is to highlight the effect of an abandoned abattoir effluent on the underground water and to suggest the possible ways of controlling abattoir effluent effect on the ground water. The problem of getting quality water for domestic purposes is increasing as untreated effluents are discharged into surface water which percolates into underground water. The impact of effluent from Mokwa abattoir in Mokwa, Niger state on the physical and chemical parameters of underground water qualities was investigated. Samples were collected at different period of time of the day and analyzed using the AOAC analytical method of 2005. The assessment of underground water parameters shows that pH, 7.2, 6.9, and 7.1, nitrogen (mgL^{-1}), 33.44, 29.48 and 33.0, total hardness (mgL^{-1}), 62, 40 and 48, and phosphate as phosphorus (mgL^{-1}), 0.06, 0.01 and 0.025, electrical conductivity ($uScm^{-1}$) was 120, 450 and 450, total dissolved solids (mgL^{-1}), 110, 225, and 225, temperature (°C), 27.2, 29.4 and 29.5, suspended solids (mgL^{-1}), 0, 3.0 and 0, turbidity (NTU), 0, 1.0 and 0, 0, 0 and 0. The World Health Organization (WHO) standard and the Nigerian Water Drinking Standard were used as a standard for comparison of these studies.

Keywords: abattoir, domestic, effluent, surface water, underground water

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Introduction

The problems associated with sewage disposal have become a major problem of the urban world due to increase in human population and urbanization. The commonality of sewage related problems throughout coastal areas of the world is significant since these areas are inhabited by over 60% of the human population. Consequently, domestic wastewater discharges are considered one of the most significant threats of the coastal environments worldwide. Environmental effects associated with domestic wastewater discharges are generally local with trans boundary implications in some areas. Coastal waters are facing a variety of pressure affecting both the ecosystem and human health through sewage wastewater discharge and disposal practices that may lead to introduction of high nutrient loads, hazardous chemicals, and pathogens causing diseases (Owili, 2003).

However, the rapid growth of the abattoir industry has resulted in serious environmental problems, especially from those staying about 500 m radius of the area. Hence there is evidence to suggest that these units extract considerable quantity of ground water from the peripheral areas and discharge the effluent without adequate treatment. The discharge of effluents has caused severe pollution of both the surface and underground water in several regions and has also contaminated agricultural land. The disposal of untreated wastewater from abattoirs is known to affect the quality of surface water, underground water and the soil not only in Mokwa but in downstream areas of the surrounding communities. Underground water contamination is the result of polluted water infiltrating through the soil and rock and eventually reaching the underground water table. This process might take many years and a distance from the well where the contamination is found. Once the underground water is contaminated, it is very difficult to remediate. No doubt that the new technologies will always reduce the pollution level. But the underground water quality in this basin based on various factors, influx of industrial effluent, influx of water through rainfall, soil, agriculture pattern etc., so we can say that by these factors, the underground water quality can be varied qualitatively and quantitatively. It is useful to examine the above highlighted problems in an environmental economic framework in which the quantity and quality of water resources is a major concern (Geetha et al., 2008).

In all countries, some form of on-the-spot slaughter either in the open or on the farm is inevitable. While the killing of animals results in significant meat supplies, a good source of protein and useful by-products such as leather, skin and bones, meat processing activities sometimes result in environmental pollution. Areas of interest in this regard include the possibility of wastes from abattoirs interacting with underground water. The concern for increases in the level of pollutants in groundwater is justified since a large proportion of rural, and recently urban, dwellers in Nigeria obtain domestic water, and sometimes drinking water, from ponds, streams, and shallow wells. Slaughter activities, if not properly controlled, may also pose dangers to the farmers and butchers as well as the consumers. Some basic principles to be followed to minimize dangers when locating and designing slaughter houses were highlighted by WHO working group on slaughter hygiene, meat inspection, and judgment. Abattoir effluent reaching streams may contribute significant levels of nitrogen, phosphorus and biochemical oxygen demand and other nutrients, thereby resulting in stream pollution (Sangodoyin and Agbawhe, 1992). Environmental problem have increased in geometric proportion over the last decades with improper management practices being largely responsible for the gross pollution of the aquatic environment with concomitants increase in water borne diseases especially typhoid, diarrhea, and dysentery. Abattoirs are general known all over the world to pollute the environment either directly or indirectly from their various processes (Adelegan, 2002). In Nigeria, many abattoirs dispose their effluent directly into surrounding streams and rivers without any form of treatment. Slaughtered meat from such abattoirs is wished using the same water (Adelegan, 2002). Recent studies on abattoir as reported by (Amusu et al., 2003) show that some of the consequence of manmade pollution is transmission of disease by water borne pathogens, entrophication of natural water bodies accumulation of toxic or recalcitrant chemicals in the soil, destabilization of ecological balance and negative effects on human health.

The continuous drive to increase meat production to meet the protein needs of the ever increasing world population has some pollution problems attached. In many countries, pollution arises from activities in meat production as a result of failure in adhering to good management and hygiene practices. Much consideration is given during animal transport to the abattoirs most especially concerning their safety, during dressing of hooves and content of alimentary tract and during evisceration. The negative impact on the environment includes microbes in the soil surface and ground water (Amusu et al., 2003; Laukova et al., 2002). The objective of this study is to highlight the effect of an abandoned abattoir effluent on the underground water and to suggest the possible ways of controlling abattoir effluent effect on the ground water.

Materials and Methods

To obtain a true indication of the nature of water or waste, it is first necessary to ensure that the samples are collected at points where wastes are introduced. Having satisfied this requirement, the analysis was carried out using (AOAC, 2005) so that results obtained by the physical and chemical analysis can be directly compared with the available standards within the country (WHO, 2007). The samples were collected from a borehole in abattoir premises (B2) in the morning by 6:30 am and in the evening by 6:30 pm while the other samples were collected from the town wells (Mokwa) by 6:30 am of the following day with the containers clearly labeled. The first sample taken by 6:30 am from the borehole of abattoir was marked AB while the second sample taken at 6:30 pm at the same abattoir borehole was marked C while the final sample was taken in the town wells by 6:30 am of the following day was marked as A which signified 12hrs interval.

Results and Discussion

Table 1 shows the various parameters tested for its compared values (WHO, 2007). From the above results, it is undoubtedly clear that abattoir effluent generated has a certain degree of effect on the underground water resources in Mokwa. Generally, analysis of underground water resources in Mokwa shows a marked difference in quality depending on the location of the source. From the results obtained ground water is clear, tasteless, and odourless, especially if it is from deep wells. It also contain low amount of solids owing to filtration through the rocks and various soil profiles which the water body has travelled through but sometimes alkaline reaction are highly mineralized for the same reason. The electrical conductivity (uScm^{-1}) were 220, 450 and 450 for both Town well 'A' Abattoir borehole water 'B' and Abattoir Borehole 'C' which are lower than the World Health Organization (WHO) limit, this can be caused from the filtration through the soil particles. Total dissolved solids (mgL^{-1}) of the samples were 110, 225 and 228 for both the three samples collected which is lower than standards less than 500 mgL^{-1}. Therefore, total dissolved solid is generally satisfactory for domestic use and many industrial purposes.

The total dissolved solids of the samples were compatible for domestic use. The laboratory observed Temperatures (^{o}C) for the various samples were 27.2, 29.4 and 29.5 though the maximum permissible limit for this was not stated for the World Health Organization (WHO) as it depends on the environmental condition at the time of collection and testing of the samples. Suspended solids (mgL^{-1}) were 0, 3.0 and O for the all samples analysis which was lower when compared with the two recommended standard, this may be attributed to screening process that is taking place through the soil profile. Turbidity (NTU) were 0, 1.0 and 0 for the three samples analyses made which make water comparable with the standards (WHO) limit 5.0 and it can be recommended for drinking and industrial works. Colours (Pvt. Co.) were 0, 0, and 0 for all three samples analyzed and they are lower

Table 1. Investigated parameters from different sources of water within 100 meters of the abattoir

Parameters	Town well 'A'	Abattoir Borehole 'B'	Abattoir Borehole 'C'	WHO
Electrical conductivity ($uScm^{-1}$)	220	450	450	1000
Total dissolved solids (mgL^{-1})	110	225	225	500
Temperature (^oC)	27.2	29.4	29.5	N/S
Suspended solids (mgL^{-1})	0	3	0	25
Turbidity (FTU)	0	1	0	5
Colour (Pvt. Co.)	0	0	0	15
pH	7.2	6.9	7.1	6.8-8.5
Iron content (mgL^{-1})	0.39	0.15	0.23	0.3
Sulphate (mg/L)	9	20	20	250
Nitrate as Nitrogen (mgL^{-1})	7.6	6.7	7.5	10
Nitrate (mgL^{-1})	33.44	29.48	33	50
Total Hardness ($CaCO_3$) (mgL^{-1})	62	40	48	100
Hardness (mg) as ($MgCO_3$) (mgL^{-1})	24.8	16	19.2	N/S
Hardness as $MgCO_3$ (mgL^{-1})	37.2	24	28.8	N/S
Total Alkalinity (mgL^{-1})	12.4	8	6.4	100
Phosphate as Phosphorus(mgL^{-1})	0.06	0.01	0.025	N/S
Zinc (mgL^{-1})	2.9	3.1	3.6	3
Magnesium (mgL^{-1})	0.13	0.15	0.17	0.2
Manganese (mgL^{-1})	0.12	0.16	0.19	0.2

than world health organization standard which is 15. Therefore by this WHO standard it is clear that the ground water is good for domestic activities.

The pH were 7.2, 6.9 and 7.1 for the three samples collected and analyzed which are within the limits standard of world health organization (WHO) 6.5-8.5 and it is recommended for drinking and other domestic uses and also for agricultural purposes. Iron contents (mgL^{-1}) were 0.39, 0.15 and 0.23 for all the three samples collected and analyzed. The obtainable values for town well water is 0.39 which is not compatible for drinking but it can be used for domestic activities while values obtained for abattoir borehole water 'B' and borehole water 'C' are compatible for drinking because the values are lower than the world health standard limits 0.3 mgL^{-1}. The iron content present in water stains plumbing fixtures, stains cloths during laundering, incrusts well screen and clogs pipes (Deutsch, 2003). Sulphate (mgL^{-1}) were 9.0, 20 and 20 which are lower that the comparative standard 250 mgL^{-1}, while Nitrate as Nitrogen (mgL^{-1}) were 7.6, 6.7 and 7.5 which are also lower than the comparative standard of 10 mgL^{-1}. Nitrate (mgL^{-1}) were 33.44, 29.48 and 33.0 which also lower than the standard (WHO) due to deepness, screening and filtration process taken place by the soil particles and it can be recommended for both industrial and domestic uses and agricultural practices. Total hardness (mgL^{-1}) were 62, 40 and 48 which are lower than the world health organization standard (WHO) and from this research it can be recommended for domestic, industrial and agricultural purposes because of lower of the values obtained compared to the WHO standard 100 mgL^{-1}. Hardness (Ca) as $CaCO_3$ were 24.8, 16 and 19.2 which the standard limits was not specified by world health organization. While hardness (mg) as $MgCO_3$ was 87.2, 24 and 28.8 which limits was also not stated by WHO and may be recommended for use. Total alkalinity (mgL^{-1}) was 12.4, 8.0, and 6.4 which is lower than the world health organization standards 100 mgL^{-1}. The low values obtained from the results can be attributed to the depth of the town well and Borehole of the abandoned abattoirs. Phosphates as phosphorus were 0.06, 0.01 and 0.025 which the limits is not stated (WHO, 2007).

Abattoir Effluent characteristics

The waste products present within the premises of the abattoir consist of

(a) Solid waste made up of pouch contents horns bones and faecal components

(b) Slurry of suspended solids, fats, blood scraps of tissue and soluble materials

All these are deposited within and outside the immediate environment of the abattoir hence, possessing some serious environmental hazards to the people of Mokwa community.

Table 1 result shows most of the water parameters fall within the world health organization limits (WHO) recommendations while some are not. Based on the chemical analysis and observations made by the author, it could be understand that the principal error made in soling construction and operation of most of the slaughter houses was the failure to make an accurate assessment of potential pollutant dangers. Though most product from the abattoir are considered to be waste products to the society but when put into actual use, such products can be a source of income to the people around there. Such by-products include, bones, pouch materials and faecal component which van be modernized and used as fertilizer.

Conclusion

The objective of this study is to ascertain if the effluent of this abandoned abattoir falls within the limit of international standard of domestic water drinking quality and its effect on underground water. The results obtained were within the range of the two International and National standard thus making these parameters not harmful while few are hazardous to the human health. It can therefore be concluded that the underground water around and within the abattoir is good for domestic, agricultural, and industrial uses.

Recommendation

The abandoned abattoir studies contained lower concentration of most of the parameters test for. Therefore; pathogens in water are agents that cause diseases in underground water quality systems. To an extent, these agents like suspended solids, total dissolved solids, bacterial, nitrate, iron hardness, sulphate, and phosphate vary from borehole to the town well as seen in Table 1. However, their presence in underground water on abandoned Mokwa abattoir do not cause significant health hazards despite the presence of these pathogens in water. Abandoned abattoir effluent handling, controlling and monitoring techniques in Mokwa must be geared towards achieving quality environmental condition for man to live in. This will go a long way to protecting natural resources such as water that are degraded by these effluents. From this framework, it's possible to articulate a position on thorough environmental management procedures to protect ground water resources in Mokwa. The following recommendations are therefore suggested.

Effluent should be recycled instead of discharging them without treatment into the surrounding environment unless otherwise, by the time abattoir restart their work, proper waste collection, and management system should be put in place by the relevant ministries. The government should enact a law which would prevent the abattoir area from being more congested as to minimize the environmental pollution due to effluent discharge. Waste disposal authorities should exercise caution in the closeness of slaughtering house and dumpsites to residential areas to ensure that the disposal of solid waste did not pose danger to public health nor cause any serious detriment to the amenities of the locality on a regular basis in order to detect departure of pollutants from natural background condition. Since it is already difficult to evacuate residents of Mokwa from the already established area; health education especially as it concerns simple water treatment processes might be necessary.

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