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THE PHYSICOCHEMICAL PARAMETERS OF EFFLUENTS ON ABA RIVER LOCATED IN ABIA STATE, NIGERIA

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ABSTRACT
The physicochemical parameters of effluents on Aba River located in Abia State Nigeria were assessed over the duration of 4 months (January through April, 2015). Parameters measured include pH, temperature, electrical conductivity, turbidity, biological oxygen demand (BOD), dissolved oxygen, chemical oxygen demand, nitrate, sulphate, organic matter and carbon levels and these were simultaneously monitored in the upper stream at Umueze using standard methods. Unacceptably, high levels of the assayed parameters were observed in many cases for nitrate ranged from 0-0.2mg/L for upper stream with a mean of 0.029 and 0-0.75mg/L for Aba River with a mean of 0.36; while dissolved oxygen ranged from4.4-13.6 for upper stream with a mean of 8.1, 3.2-11.6mg/L for Aba River with a mean of 6.4; turbidity ranged from 86-97NTU and 90-94NTU for the two sampling point and means of 91.1and 91.7 respectively. Conductivity ranged from 133- 450**µscm¯** with a mean of 301.4**µscm¯** for upper stream and 90 - 96 **µscm¯** with a mean of 91.7**µscm¯** for Aba River ;Ph range of 6.65 -7.45 with a mean of 6.91 for upper Stream and 6.85 – 7.84 with a mean value of 6.91, and 6.8 5 – 7.48 with a mean value of 7.06; sulphate ranged from 5. 53 – 35.48mg/L with a mean of 16.96mg/L for upper stream and 3.46 – 46.54mg/L with a mean value of 19.21mg/L for Aba River; COD ranged from 2.0 – 6.0mg/L with a mean value of 4.0mg/L for upper stream and 0.8 – 7.2mg/L with a mean value of 3.49mg/L. The study has revealed that there was an adverse impact on the physiochemical characteristics of the Aba River as a result of the discharge of untreated effluents from the wastewater from Abattoir facility. This poses a health risk to several rural communities which rely on the receiving water bodies primarily as their sources of domestic water. There is need for the intervention of appropriate regulatory agencies to ensure treatment of Abattoir wastewater prior to disposal in the River.

KEYWORDS: Biological/Chemical Oxygen Demand, Nitrate, Dissolve Oxygen, Conductivity, pH. Dissolved Oxygen

INTRODUCTION
The present estimation of consumable water levels is placed at 1% with ground water levels also threatened by pollution (Nwakanma and Oleh, 2013; Watson and Cichra, 2006). Water contaminated by effluent from various sources is associated with heavy disease burden (Okoh, 2007) and this could influence the current shorter life expectancy in the developing countries compared with developed nation (WHO, 2002; 2004). Freshwater has become a scare commodity due to over exploitation and pollution (Patil and Tijare, 2001; Singh *et al*., 2005). Pollution is caused when a change in the physical, chemical or biological condition in the environment harmfully affect quality of human life including other animals' life and plant (Lowel and Thompson, 1992; Okoye *et al*., 2002). Agricultural, Industrial, sewage and municipal wastes are been continuously added to water bodies hence affect the biological and physiochemical qualities of water making them unfit for use of livestock and other organisms (Adigun, 2005). The Abattoir industry is an important component of livestock industry in Nigeria, providing domestic meat supplies to over 150 million people and employment opportunities for the teaming population [Nafamda *et al.*, 2012]. Waste water from an abattoir is particularly concentrated source of oxygen consuming wastes [Girards, 2005]. Abattoirs generally use large quantities of water for washing meat and cleaning process areas [Kuyeli, 2007] and they are usually located near water bodies in order to gain access to water for processing. Contamination of river body and

land from abattoir wastes could constitute a significant environmental and health hazard [Coker *et al.*, 2001; Nafamda *et al.*, 2006; Osibanjo and Aide, 2007]. Wastes from the slaughter house typically contain fat, grease, hairs, feathers, flesh, manure, grit and undigested feed, blood, bones and process water which is typically characterized with high organic level [Coker *et al.*, 2001; Nafamda *et al.*, 2006].The animal blood is released untreated into the flowing stream while the consumable parts of the slaughtered animal are washed directly into the flowing water [Adelegan, 2002]. The total amount of waste produced per animal slaughtered is approximately 35% of its weight [World Bank, 1998]. According to [Omole and Longe, 2008], abattoir effluents could increase levels of nitrogen, phosphorus, total solids in receiving water bodies considerably. Excess nutrients cause the water body to become choked with organic substances and organisms. When organic matter exceeds the capacity of the micro-organisms in water that breakdown and recycle the organic matter, it encourages rapid growth or blooms of algae leading to eutrophication. Facilities for treatment of abattoir effluents are lacking unlike in developed countries where these facilities are adequately provided [Ogbonnaya, 2008]. Improper disposal systems of wastes from slaughter houses could lead to transmission of pathogens to humans and cause zoonotic diseases such as *Bacillosis, Salmonellosis, Brucellosis,* and *Helminthes, Pseudomonasis* [Sherer *et al.,* 2008]. Such contamination of water bodies could constitute significant environmental and public health hazards [Coker *et al.,* 2001; Nafamda *et al.,* 2006; Osibanjo and Aide, 2007; World Bank, 1998]. The causative factors responsible for the deteriorating water quality in most developing countries are quite similar. For instance, the city of Aba which is one of the indigenous commercial cities in South-Eastern part of Nigeria has several inter-related factors which directly or indirectly impact the quality of water bodies within the city. These are largely due to improper waste disposal, untreated industrial and Abattoir effluent disposal into these water bodies, poor physical planning and increasing population pressures on the dilapidated infrastructures within the city. The consequences of these illicit practices are quite enormous; many villagers living several miles away from the city who often depend on water from these polluted streams and rivers for their drinking and sanitation purposes are not exempted from these effects. Incidentally, the extracted water by these villagers, in most cases, is not subjected to any form of chemical treatment prior to their use. Although most of these streams and rivers do exhibit some natural regenerative potential as they flow further downstream, the extent to which these can be achieved generally depends on but not limited to these factors, namely the quality of Abattoir waste water discharged, the proximity of the village or other extraction points to the city and the hydrodynamics of the stream or river concerned. As a result of the increasingly difficulty little attention is paid to the potential impacts of discharges of untreated, partially treated or treated industrial and agricultural effluents on the water quality of the receiving water bodies. Usually, the impact of agricultural discharges are difficult to assess because there is no clear cut between the water pollution caused by Abattoir waste water, and that contributed by industrial activities and improper management of solid wastes. Aba River is among the major Rivers found in Abia State; Aba the commercial city of Abia State in South-eastern Nigeria. As surface water in a developing country, and in accordance to UNEP (1993), it may be predisposed to pollution due to high population growth and indiscriminate waste disposal. Some industries also discharge their waste water into the river. There are many published reports on Nigerian rivers but there is limited data on Ogbor-hill River due to its importance as resource to\ Aba Metropolis and its delicate environments, the present study investigated the effect of Abattoir waste water on the microbial population of Aba River.

MATERIALS AND METHODS

Aba, Abia state, Nigeria lies along the west bank of the Aba River, at the intersection of roads from Port Harcourt, Owerri, Umuahia, Ikot Ekpene, and Ikot Abasi (Opobo). Geographically, Aba is located within **Latitude $5^0$6.3948N and Longitude 7^0 22.0002E** within the forest belt. The area is characterized by high temperatures of about 29^0-31^0c and double maximal rainfall peaks in July and September. It has an area of 24**5km^2** and a population of 897**5**60 at the 2006 census, with an altitude of 20**5m** (NPC, 2014).

Aba is a city and a big trading center, upon the creation of Abia State in 1991, Aba was divided into two local government areas namely; Aba South and Aba North. Aba is made up of many villages such as, Umuokpoji Aba, Eziukwu-Aba, Obuda-Aba, Aba-Ukwu and other villages from Ohazu merged due to administrative convenience. It lies along the west bank of the Aba River and is at the intersaction of roads leading to Port harcourt, Owerri, Umuahia, Ikot Ekpene and Ikot Abasi. The city became a collecting point for agricultural products following the British made railway running through it to Port Harcourt. Aba is a major urban settlement and commercial center in a region that is surrounded by small villages and towns. The indigenous people of Aba are the Ngwa. Aba is well known for its craftsman.

The abattoir is situated beside Ogbor-hill Bridge along Ikot-Ekpene road. The structure has an elevated concrete floor slab, which serves as a slaughtering surface with discharge channels directed to the flowing water. A certain amount of animals such as cows, goats and pigs are slaughtered daily. In abattoir, estimate of 500 – 700 cows are slaughtered on weekdays. The cows are killed manually by falling the cows with strong thick ropes. The cows are killed with sharp deep knife cut through the neck, releasing blood and led to the complete death of the animal. At this stage, the animals are dissected into parts and the internal organs (such as kidney and intestines) are opened up to remove waste. The waste accruing from these animals includes blood, flesh particles, soluble protein, urine, faeces and other organic materials. There are small drainage channels around the slab that is connected to a large channel through which the animal waste is being discharged into the water body. Water-taps and pumping machines are mounted around the slab area used to supply the water in preparing the slaughtered animal and washing the slab after the slaughtering of the animals. Three sampling points were established along the course of the river covering a distance of approximately 4km. Sampling point one (1) was located upstream at Umueze area and 2km before the Abattoir, the second sampling point, while the third (3) sampling point was located 2 kilometers from area of Abattoir operation. The samples used in determining the influence of the abattoir wastewater on the receiving river were collected in two liters plastic bottles between the hours of 8 to 9am in the morning, aseptically from the four sampling stations along the Aba River during the same flow direction, at monthly intervals from September through December 2014. Each sample for analysis was collected using a clean two litre plastic container with a screw cap which was thoroughly washed with detergent, soaked with acid and rinsed with distilled water. All the samples were stored in laboratory, firstly refrigerated at 4°C in a cooler packed with ice blocks prior to analysis to avoid microbial action affecting their concentration. The samples were taken to the laboratory for further analysis within 24 hours of collection. The physiochemical properties of the water samples were determined according to standard methods. The physicochemical properties determined include Temperature, pH, Dissolved Oxygen (DO), Conductivity, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Nitrate, and Phosphate according to standards recommended by AOAC 1990.

RESULTS

Table:1 The Physiochemical Parameters Of Aba River At Umueze Area (Upper Stream)

	January	February	March	April
DO(mg/l)	3.1	8.4	11.6	5.6
BOD(mg/l)	1.6	0.8	6.0	0.4
Temperature(^{0}C)	23	19	23	23
Turbidity(NTU)	86	93	90	86
Conductivity	373	133	270	243
pH	7.45	7.25	6.65	6.7
Nitrate(mg/l)	0.65	0.25	0.75	0.35
Sulphate ion(mg/l)	8.30	5.53	11.75	26.06
Organic matter(mg/l)	1.26	2.58	2. 58	2.84
Organic Carbon(mg/l)	o.75	1. 50	2.25	1.64
COD(mg/l)	2.0	4.0	4.0	6.0

Table: 2 The Physiochemical Parameter Of Aba River At The Abattoir

	January	February	March	April
DO(mg/l)	6.0	11.2	11.6	5.6
BOD(mg/l)	5.2	4.8	6.0	0.4
Temperature(^{0}C)	26	18	23	23
Turbidity(NTU)	90	92	90	86
Conductivity(**µscm⁻**)	234	224	270	243
pH	7.48	6.85	6.65	6.70
Nitrate(mg/l)				
Sulphate ion(mg/l)	6.92	3. 46	26.54	26.06
Organic Matter(mg/l)	1.03	0. 53	2.84	2.84
Organic Carbon(mg/l)	0.6	0.3	1.65	1.64
COD(mg/l)	1.6	0.8	4.4	6.0

Table: 3 Summary Of Basic Statistics For Aba River At Umueze(Upper Stream)

	Range	Mean	Standard deviation	Threshold = X + 2S	Coefficient of Variation
DO(mg/l)	3.2 – 11.6	6.4	2.63	11.66	0.41
BOD(mg/l)	0.4 – 6.0	2.09	1.82	5.7	0.88
Temperature(^{0}C)	17 – 23	17.7	2.25	22.2	0.13
Turbidity(NTU)	86 – 97	91.1	4.22	99.54	0.005
Conductivity	133 - 450	301.4	102.4	506.2	0.34
pH	6.65 – 7.45	6.91	0.29	7.49	0.042
Nitrate(mg/l)	0 – 0.75	0.36	0.28	0.92	0.78

Sulphate ion(mg/l)	5.53 – 35.48	16.96	17.49	51.94	1.03
Organic Matter(mg/l)	1.29 – 3.88	2. 25	1.01	4.27	0.48
Organic Carbon(mg/l)	0.75 – 2.25	1.31	0.93	3.17	0.71
COD(mg/l)	2.0 – 6.0	4.0	1. 57	7.14	0.39

Table 4: Summary Of Basic Statistics For Aba River At The Abattoir

	Range	Mean	Standard deviation	Threshold = X + 2S	Coefficient of Variation
DO(mg/l)	4.4 – 13.6	8.1	3.10	14.3	0.38
BOD(mg/l)	1.6 – 9.2	4.4	2.48	9.36	0. 56
Temperature(^{0}C)	18 – 26	17.86	2.81	23.48	0.16
Turbidity(NTU)	90 – 96	91.7	1.38	94.46	0.02
Conductivity	185 – 234	209.7	18.9	247. 5	0.09
pH	6.85 – 7.48	7.06	0.22	7. 50	0.03
Nitrate(mg/l)	0 – 0.2	0.029	0.08	0.19	27.6
Sulphate ion(mg/l)	3.46 – 46.54	19.21	1 5.42	50.05	0.8
Organic Matter(mg/l)	0.52 – 4.65	2.58	1.6	5.78	0.62
Organic Carbon(mg/l)	0.3 – 2.70	1.50	0. 59	2.68	0.39
COD(mg/l)	0,8 – 7.2	3.49	2.48	8. 45	0.71

DISCUSSION

The pH regimes vary significantly ($P < 0.05$) in the water bodies throughout the study period and ranged from 6.65 to 7.45 for upper Stream and 6.85-7.48 for Aba River. Generally, the obtained pH values fall within the World Health Organization standard of 7.0 to 8.5 and the water quality ranges 6.5 to 8.5 for drinking water and water meant for full contact recreation, respectively (DWAF, 1996b; WHO, 1984; 1989). The EU also sets pH protection limits of 6.0 to 9.0 for fisheries and aquatic life (Chapman, 1996).

The temperature profile of Aba River varied significantly ($P < 0.05$) and ranged from 17 to 23 °C for upper Stream; 18 to 26 °C for Aba River at the Abattoir. 25 °C is the recommended limit for no risk according to the FEPA water quality guidelines for domestic use (DWAF, 1995) while 40°C is recommended limit according to WHO. Based on these guidelines, the temperature variations does not appear to pose any threat to the homeostatic balance of the receiving water bodies, in conformity with the report of Jaji *et al.* (2007). It will however reduce solubility of oxygen and amplified odour due to anaerobic reaction.

The dissolved oxygen profile through the period varied significantly ($P < 0.05$) and ranged from 3.2 to 11.6 mg/L for upper stream; 4.4 to 13.6 mg/L for Aba River. The DO content of the River 2km away from the Abattoir which was observed to deplete faster than DO from the receiving water body could be attributed to the presence of degradable organic matter which resulted in a tendency to be more oxygen demanding. Dissolved oxygen is an important factor used for water quality control. The effect of waste discharge on a surface water source is largely determined by the oxygen balance of the system and its presence is essential in maintaining biological life within a system (DFID,1999). Dissolved oxygen concentrations in unpolluted water normally range between 8 and 10 mg/L and concentrations below 5 mg/L adversely affect aquatic life (DFID, 1999; Rao, 2005). DO standard for drinking purpose is 6 mg/L whereas for sustaining fish and aquatic life is 4-5 mg/L. The DO value from this study fell short of the recommended standard. For water quality variable such as dissolved oxygen, water quality criteria are set at the minimum acceptable concentration to ensure the maintenance of biological function.

The electrical conductivities of the water samples generally varied significantly ($P < 0.05$) and ranged from 133µs/cm to 450µs/cm for upper Stream; 185µs/cm to 234µs/cm throughout the period of study.

Higher conductivities were observed in upper Stream than Aba River. Electrical conductivity is a useful indicator of mineralization and salinity or total salt in a water sample. The FEPA acceptable limit for conductivity in domestic water supply is 70µs/cm (DWAF, 1996a). This limit was exceeded in the receiving water body. Thus, the parameter does give concern and it could make the water unsuitable for direct domestic use. The conductivity values obtained in this study is similar to the findings of previous study on the Keiskamma River (Fatoki *et al.*, 2003).

The turbidity profile varies significantly ($P < 0.05$) amongst the water bodies throughout the study period and ranged from 86 to 97 NTU for upper Stream; 90 to 94 NTU for Aba River. The turbidity values obtained from the sampling points were higher than WHO standard of 5 NTU (WHO, 2004). None of the receiving water body met the FEPA guideline of 0 to 1 NTU for turbidities in water for domestic use (DWAF, 1998). These values are grossly exceeded in the water samples and it disqualifies the receiving water body for direct domestic use. Also, the excessive turbidity in water can cause problem with water purification processes such as flocculation and filtration, which may increase treatment cost (DWAF, 1998). High turbid waters are often associated with the possibility of microbiological contamination, as high turbidity makes it difficult to disinfect water properly (DWAF, 1998).

Both the BOD and COD tests are a measure of the relative oxygen-depletion effect of a waste contaminant. Both have been widely adopted as a measure of pollution effect. The BOD test measures the oxygen demand of biodegradable pollutants whereas the COD test measures the oxygen demand of oxidizable pollutants. The COD is a determinant of the level organic matter and carbon. An indication of organic oxygen demand content of wastewater can be obtained by measuring the amount of oxygen required for its stabilization either as BOD and COD. Biological Oxygen Demand (BOD) is the measure of the oxygen required by microorganisms whilst breaking down organic matter. While Chemical Oxygen Demand (COD) is the measure of amount of oxygen required by both potassium dichromate and concentrated sulphuric acid to breakdown both organic and inorganic matters. BOD and COD concentrations of the water body were measured, as the two were important in unit process design. The chemical oxygen demand (COD) of the water bodies generally varied from 2.0 to 6.0 mg/L for upper Stream; 0.8 to 7.2 for Aba River throughout the study period. Higher levels of COD were observed downstream of the Abattoir discharge point. This is undesirable since continuous discharge of effluent has impacted the receiving water body to some extent and this may have negative effects on the quality of the freshwater and subsequently cause harm to the aquatic life especially fish, downstream (Morrison *et al.*, 2001). When this present result was compared with results of COD of the upper Stream and receiving water bodies from developed countries, it was observed that the concentrations of COD differ as reported by UNEP (1993). According to Ogunfowokan *et al.* (2005), this increase in COD could also be attributed to an increase in the addition of both organic and inorganic substance from the environment, as well as organic contaminant entering the systems from the municipal sewage treatment plants. In the same light, one observation agrees with the previous works of Fatoki *et al.* (2003) who reported that the contribution of Abattoir wastewater to COD of effluent and receiving water bodies in Nigeria appears to be significant.

The most highly oxidized form of nitrogen compounds is commonly present in surface and groundwater because it is the end product of aerobic decomposition of organic nitrogenous matter. Unpolluted natural waters usually contain only minute amounts of nitrate (Jaji *et al.*, 2007). In this study, the nitrate-N concentrations ranged between 0 to 0.75 mg/L during the period for upper Stream; 0 and 0.2 mg/L for Aba River and changed significantly ($P < 0.05$). It is important to note that nitrate level in the stream could be a source of eutrophication for receiving water as the obtained values exceeded the recommended limit for FEPA. The effluent from the treatment works could be considered as a source of nitrate into the receiving water body. The high nutrient levels in the upstream discharge point of the receiving water may be as a result of diffuse sources from settlement and agricultural runoff.

REFERENCES

1. Adelegan, J. A. Environmental policy and slaughterhouse waste in Nigeria. Proceedings of the 28th WEDC Conference, Calcutta, India, 2002; 3-6.
2. Adigun, B. A. (2005) water quality management in aquaculture and freshwater zooplankton production for use in fish hatcheries vol.
3. Coker, A. O.,Olugasa, B. O., and Adeyemi, A. O. (2001). Abattoir and wastewater quality in South Western Nigeria," in Proceedings of the 27th Water, Engineering and Development Centre Conference, Lusaka, Zambia, 2001.
4. Calamari, D.; Naeve, H., (1994). Review of pollution in the African aquatic environment. Committee for Inland Fisheries of Africa (CIFA) Technical paper No. 25, FAO, Rome, 118.
5. Chapman, D., (1996). Water quality assessments: A guide to the use of biota, sediments and water in environmental monitoring 2nd. Ed. UNESCO, World Health Organization, United Nations Environment Programme, London.
6. Department of DWAF; WRC, (1995). South African water quality management series. Procedures to Assess Effluent Discharge Impacts. WRC Report No. 24 TT 64/94. Department of Water Affairs and Forestry and Water Research Commission, Pretoria. Water Affairs and Forestry, Pretoria.
7. DFID, (1999). A Simple Methodology for Water Quality Monitoring. G. R. Pearce, M. R. Chaudhry and S. Ghulum (Eds.), Department for International Development Wallingford. 100.
8. DWAF, (1995). South African water quality management series. Procedures to Assess effluent Discharge Impacts. WRC Report No. TT 64/94. Department of Water Affairs and Forestry and Water Research Commission, Pretoria.
9. DWAF, (1996a). South African Water Quality Guidelines. Domestic Uses. 2nd. Ed. Department of Water Affairs and Forestry, Pretoria, Vol. 1.
10. DWAF, (1996b). South African Water Quality Guidelines, (Volume 2), Recreational Water Use (2nd Ed.).
11. DWAF, (1996c). South African Water Quality Guidelines, Aquatic ecosystems (1st. Ed.). Department of Water Affairs and Forestry, Pretoria, Vol. 7.
12. DWAF, (1996d). South African Water Quality Guidelines, Agricultural water use irrigation (2nd. Ed.). 4, Department of Water Affairs and Forestry Pretoria. RSA.
13. DWAF, (1998). Quality of Domestic Water Supplies. Assessment Guide. 1 (2nd. Ed.) Department of Water Affairs and Forestry,

Department of Health and Water Research Commission.
14. DWAF, (1999). Quality of domestic water supplies. Sampling Guide 2. Department of Water Affairs and Forestry, Department of Health and Water Research Commission.
15. Dwivedi, B.K.and G.C.Pandey. Physico-chemical factors and algal diversity of two ponds in Faizabad, India Poll.Res. 2002; 21(3): 361-370.
16. Fatoki, S. O.; Gogwana, P.; Ogunfowokan, A. O., Pollution assessment in the Keiskamma River and in the impoundment downstream. Water SA., 2003; 29(3): 183-187 (5 pages).
17. Girards, J. (2005). Principle of Environment Chemistry, Jones & Bartlett, USA. Pp. 12-23
18. Gupta, G. K., Shukle, R., Physiochemical and Bacteriological Quality in Various Sources of Drinking Water from Auriya District (UP) Industrial Area. Pollution Research, 2006; 23(4): 205-209.
19. Jaji, M. O.; Bamgbose, O.; Odukoya, O. O.; Arowlo, T. A., (2007). Water quality assessment of Ogun River, south west Nigeria. Environ. Monit. Assess., 2007; 133(1-3): 447-482 (36 pages).
20. Lloyd, B.; Helmer, R., Surveillance of drinking water quality in rural area. Longman Scientific and Technical Publication. New York, Wiley. 1992; 34-56.
21. Lowel and Thompson F., Biodiversity of vibrios. Microbiol. Mol. Biol. Rev., 1992; 68: 403-431.
22. Nafarnda, W. D., Yaji, A. and Kubkomawa, H. I., Impact of abattoir waste on aquatic life: a case study of Yola abattoir," Global J. Pure and Appl. Sci. 2006; 12: 31-33.
23. Nafarnda, W. D., Ajayi, I. E., Shawulu, J. C., Kawe, M. S.,Omeiza, G. K., Sani, N. A., Tenuche, O. Z., Dantong, D. D.,and Tags, S. Z. (2012). Bacteriological quality of Abattoir effluents discharged into water bodies in Abuja, Nigeria. ISRN Vet. Sci. 2012, article I.D515689.
24. Nwakanma, C. and Oleh, K. F; Comparative Study of the Physiochemical and Microbial Evaluation of Different Brands of Bottled, Sachet, Tap, Well water in Enugu Metropolis. Proceedings of the 2nd Biennial International Conference on Biotechnology and National Development, 2013; 9-13.
25. Ogbonnaya, C.(2008). Analysis of groundwater pollution from abattoir waste in Minna, Nigeria,"Res. J. Dairy Sci., 2008; 2(4): 74-77.
26. Ogunfowokan, A. O.; Okoh, E. K.; Adenuga, A. A.; Asubiojo, O. I., Assessment of the impact of point source pollution from a University sewage treatment oxidation pond on the receiving stream-a preliminary study. J. App. Sci., 2005; 6(1): 36-43.
27. Okoh, A. I., Wastewater treatment plants as a source of microbial pathogens in the receiving watershed. Afr. J. Biotech., 2007; 6(25): 2932-2944 (13 pages).
28. Okoye, P. A. C., Enemuoh, R. E. and Ogunjiofor, J. C., Traces of heavy metals in Marine crabs. J. Chem. Soc. Nigeria, 2002; 27(1): 76-77.
29. Omole, D. O., and Longe, E. O. (2008). An assessment of the impact of abattoir effluents on River Illo, Ota, Nigeria. J. Environ. Sci. and Technol. 1(2):2008, 56-64.
30. Osibanjo, O.,and G. U. Adie, (2007). Impact of effluent from Bodija abattoir on the physicochemical parameters of Oshunkaye stream in Ibadan City, Nigeria," Afri. J. Biotechnol. 2007; 6(15): 1806-1811.
31. Pandey, Trends in eutrophication research and control. Hydrol. Proc., 2003; 10(2): 131-295(165 pages).
32. Patil D. B., Tijare, R. V., (Dept Chem, Govt Sci Coll, Gadchiroli 442605). Investigation of pollution mystery of suspected carcinogen Cr (VI) and its control. J Indl Polln Contl, 2001; 17(1):43-47 [4 Ref].
33. Sandoyin, Eutrophication trends in the water quality of the Rhode River. J. Mar. Biol. Assoc., 1991; 54: 825-855 (31 pages).
34. Sherer, B. M.,Miner, R. J., Moore, J. A., and Buckhouse, J. C. Indicator bacterial survival in stream sediments, J. Environ. Qual. 2008; 21(4): 591–595.
35. Singh R. P, Mathur, P. (Dept Environ Std, MDS Univ, Ajmer 305 009). Investigation of variations in physico-chemical characteristics of a fresh water reservoir of Ajmer city, Rajasthan. Indian J Environ Sci, 2005; 9(1): 57-61 [15 Ref].
36. UNEP, Environmental data report (93/94). United Nation Environment Programme, Blackwell, Oxford, UK, 1993; 63-105.
37. Watson, C. and Cichra; C. E. (2006) Department of fisheries and Aquatic Sciences florida cooperatives extension services. Institute of food and Agriculture sciences, University of florida. First edition; June 1990, second edition, 2006.
38. WHO, Guideline for Drinking Water Quality Recommendation. World Health Organization, Geneva, 1984; 1, 130.
39. WHO, (1989). Health guidelines for use of wastewater in agriculture and aquaculture. World Health Organization. Technical Report Series 778. Geneva, Switzerland.
40. WHO, (2002). Water and health in Europe: A joint report from the European Environment Agency and the WHO Regional Office for Europe. World Health Organization, WHO Regional Publications, European Series No. 93.
41. WHO, (2004). Rolling revision of the WHO guidelines for drinking-water quality, Draft for review and comments. Nitrates and Nitrites in drinking-water, World Health Organization. (WHO/SDE/WSH/04.08/56).
42. World Bank, "Poor Management of Processing Wastes. Environmental Assessment: Pressure State Response Indicators," Pollution Prevention and Abatement Handbook, 1998.