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Aquatic Environmental Contamination: The fate of Asejire Lake in South-Western Nigeria

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In Nigeria major cities face serious water pollution crises, in which lack of environmental control of water-dependent activities play an important part. This generates unpleasant implications for health and economic development since most urban and rural areas depend upon lakes and rivers for their water supplies. A study of catfish from Asejire Lake (located at the outskirt of Ibadan, a major city in Oyo State of South-West Nigeria) was carried out to assess the level of contamination due to effluents from various industries in Ibadan, Oyo State particularly the Nigerian Bottling Company, Plc (NBC). The industrial site is located close to the lake and is known to be passing effluent to it. Heavy metals analysis was carried out by the use of an atomic absorption spectrophotometer (AAS) using an air-acetylene flame in the Alpha-4 ChemTech spectrophotometer. The result shows that Fe had the highest concentration (11.9 ppm), this was evidenced by an absorption peak at 406 nm and the high level of Fe after its AAS metal determination experiment. The other metals gave the following concentration: Ni (0.9 ppm), Mg (0.47 ppm), Mn (0.45 ppm), Zn (0.35 ppm), Ca (0.06 ppm), Cu and Co (0.00 ppm). These metals had a threshold in which the body can take before they will be lethal, as a result, accumulation and continuous consumption of these aquatics and drinking of the water can lead to coma or death. Fish stocks are at the upper end of the food chains and are vital food supplies to local populations and thus they present a major source of contaminants to local communities. Therefore this project highlights the need for environmental regulation and policy intervention in other to prevent the risk attached to accumulation of these contaminants via the water and the aquatic life. This paper focused on the instruments needed by the policy maker to be better informed and understand how to create a cleaner environment for people so as to increase the economy, health and well being of the people.

Key words: Asejire lake, pollution, contamination, catfish.

INTRODUCTION

Over the last years, in Nigeria a considerable population growth has taken place, accompanied by a steep increase in urbanization, industrial and agricultural land use. This has entailed a tremendous increase in discharge of a wide diversity of pollutants to receiving water bodies and has caused undesirable effects on the different components of the aquatic environment and on fisheries (Tolba, 1982). Organic pollution of inland waters in Nigeria, in contrast to the situation in developed countries of the world, is often the result of extreme poverty and economic and social under-development.

Unfortunately, there are very few water quality studies for most Nigerian inland waters. In general, the available data come from scattered investigations which were carried out by individuals and by very few scientific projects concerned with Nigerian waters. Few reviews exist on their

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state of pollution (Dejoux et al., 1981; Dejoux, 1988; Burgis and Symoens, 1987; Davies and Gasse, 1988). Throughout the world, human use of water and bad planning have led to drier and polluted rivers, lakes, and groundwater resources with dramatic effects on the natural ecosystems. Nigeria's vast freshwater resources are among those most affected by environmental stress imposed by human population growth, urbanization, and industrialization. Disposal and management of wastes in Nigeria present serious environmental problems. The usual methods of waste disposal in the country are: land filling, dumpsites, land spreads, water disposal, and incineration. Each of these methods has serious environmental implications because of their potential to pollute and contaminate underground and surface water bodies in the country (Olanike, 2003).

Major cities in Nigeria face serious water pollution crises, in which lack of environmental control of water-dependent activities (including domestic, agricultural, and industrial) play an important part. Fish and marine resources in the country face total collapse or extinction, due to over-fishing and destruction of marine life and natural habitats by pollution of water bodies. Unregulated and excessive use of pesticides for fishing and the deliberate disposal and dumping of toxic and hazardous wastes into water bodies are significant causes of massive fish kills and loss of aquatic life and habitats in the country.

The protection of water quality and aquatic ecosystem as a vulnerable resource, essential to sustain life, development and environment is of utmost importance to prevent further pollution and degradation of Nigeria's freshwater resources. Integrating operational measures for safeguarding adequate levels of protection of endemic habitats remains a major challenge (Olanike, 2003).

Due to population and industrial growth, inland waters (rivers, lakes, etc.) become often the recipient of organic matter in amounts exceeding their natural purification capacity; while in the past natural purification and dilution were usually sufficient. Sewage and other effluents rich in decomposable organic material, cause primary organic pollution. Secondary organic pollution is defined as the surplus of organic matter, which is the sum of undecomposed organic material introduced into the water body with primary pollution and of the material resulting from an extremely increased bioproductivity within the polluted ecosystem itself (Stirn, 1973).

As stated by Dejoux et al. (1981), organic wastes mineralize in the receiving water bodies and the resulting nutritive elements stimulate plant production, leading to eutrophication. In this situation, the biomass increases considerably and goes beyond the assimilation limit by herbivores. This secondary organic pollution is considerably greater than the primary organic load. The excessive production of organic matter leads to the build up of “sludge” and the mineralization process consumes all dissolved oxygen from the water column, which causes fish kills. Consequently, organic pollutants are called oxygen-demanding wastes. The relatively high temperatures in tropical countries accelerate this process.

Rain water transports soil to streams, rivers and lakes by erosion processes, including dissolved and particulate organic matter.

Decomposition of this organic matter continues during transport and in the sediments, giving new soluble organic and inorganic matter. The quantities of organic matter transported, its characteristics and composition vary from one region to another. A man-made transport mode of organic material to natural receiving waters is sewage pipes. Man himself is unable to use all the energy stored in food and his wastes are often discharged into the water without treatment. It is well known that untreated sewage creates a public health danger, being a potential for epidemics of water-borne diseases, such as typhoid fever, and also causes a serious loss of the recreational value of the inland waters (Stirn, 1973; Shuval, 1986).

In addition to the ever-increasing urbanization, industry and development of agriculture and forestry contribute considerably to the organic loads, which pose a hazard for inland waters and fisheries. Accordingly, domestic sewage and organic industrial wastes, as well as wastes from agricultural and forestry products are considered as main sources of organic pollution of African waters. Alabaster (1981) pointed out that agriculture is being further developed in some African countries, leading to an extension of existing industries involved in the processing of plant and animal products and to an increase in the highly oxidizable discharges.

Lake Asejire is located in Southwestern Nigeria in Egbeda L.G.A. of Oyo State (Figure 1). It is a manmade lake constructed on River Osun in 1972. River Osun is one of the series of West African rivers which do not drain into Niger system but discharge into coastal lagoons and creeks bordering the Atlantic Ocean (Ayoade et al., 2006). Lake Asejire has elevated levels of contaminants due to effluents from various industries and breakdown of ecological balance caused by widespread destruction of flora and fauna diversities (Lameed and Obadara, 2006). One of such industries is the Nigerian Bottling Company, Plc (NBC) situated in the outskirt of Ibadan, Oyo state.

A study was carried out by Lameed and Obadara (2006) to assess the activities of Nigerian Bottling Company, Plc (NBC), Coca Cola Industry (both positive and negative) on the biodiversity of the area of Asejire. Parameters analyzed were Dissolved Oxygen Concentration, pH, temperature, turbidity and some heavy metals. Results showed that family Palmae (flora) and Archachatinidae (fauna) have the largest population abundance with 24.32 and 18.64%, respectively. The water sample collected showed a pH of 5.7, 6.3 and 6.5 at different points of the Lake. This is an indication of acidic water and might be toxic for human consumption except treated to comply with the World Health Organization recommended pH 7, for safe and drinkable water (Lameed and Obadara, 2006).

Figure 1. Asejire Lake where the fish samples were collected.

Figure 2. The African Cat fish used for this study.

Asejire Lake, which is the focus of this study, has elevated levels of contaminants due to effluents of various industries in Ibadan, Oyo State. Previous researchers have established the presence of pollutant in the water. In the local traditional settings around the river Osun, from which Asejire lake was built, it is a common thing for cassava tubers to be steeped in the flowing river for processing into other food products. This is a major source of cyanide pollution in this water. Despite this high level of pollution, the lake still support aquatic lives and serves the populace. Cyanide, a rapidly acting poison is one of the likely chemical pollutants present in the water. There is a need to assay various parameters to obtained information on the level of pollution of the water and the health implication.

MATERIALS AND METHODS

Asejire Lake; the study area is located in Egbeda Local Government area of Oyo state in Nigeria (Figure 1). The study was carried out by analysing fish samples from the lake to determine the level of pollutant and its possible effect on man. The part of the fish used for the analysis was the liver because it is solely responsible for detoxification of any poison or pollutant in the fish (Figure 2). The parameters that were assessed include heavy metals, temperature, and pH.

Heavy metals

The sample was examined for the presence of various divalent metal ions: Iron (Fe), magnesium (Mg), manganese (Mn), calcium (Ca), cobalt (Co), zinc (Zn), nickel (Ni) and copper (Cu). These metals were estimated by atomic absorption spectrophotometer

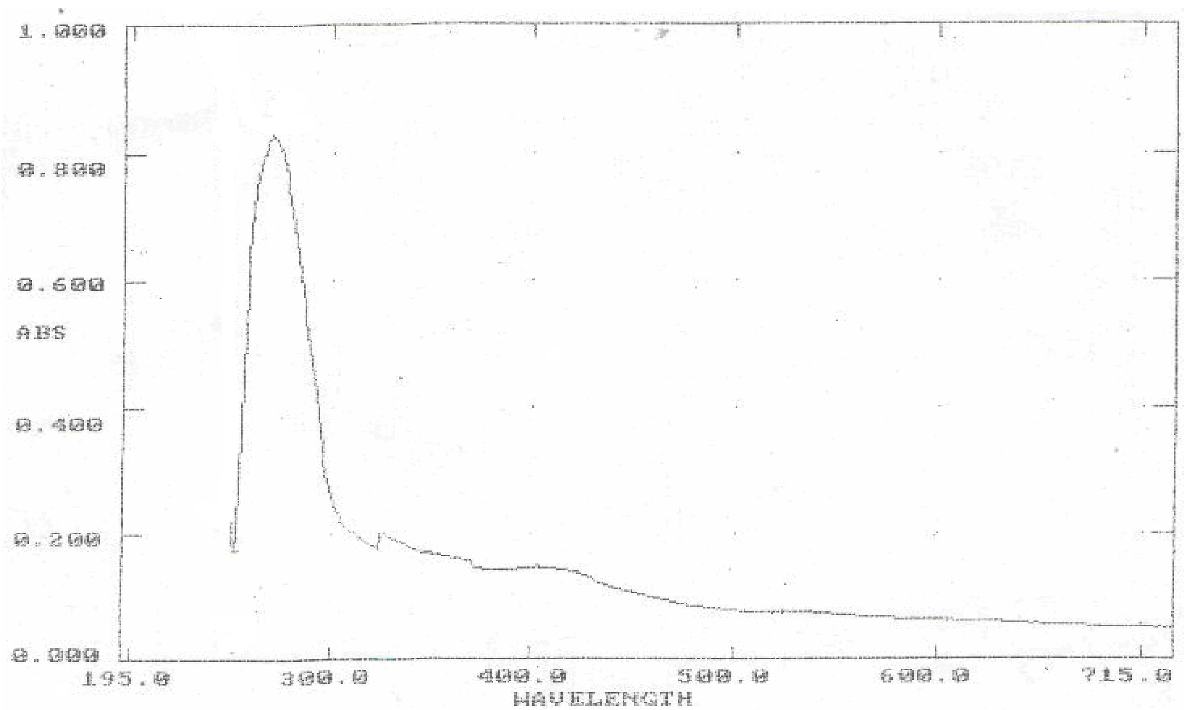

Figure 3. Spectrophotometric scanning.

using an air-acetylene flame in the Alpha-4 ChemTech spectrophotometer (Figure 3). The liver sample was digested in the presence of mixture of concentrated HNO_3 and $HClO_4$ (1:1). Prior to analysis, the sample was extensively dialysed against double change of distilled water to remove any ions contributed by the buffer according to the methods of Kaur et al. (2006).

Temperature

The optimum temperature and the heat stability of the sample was determined as follows:

Optimum temperature

The sample was assayed at temperatures between 0 and 70°C to investigate the effect of temperature on the activity of the liver and to determine the optimum temperature at which the detoxification of pollutants can occur. The sample was first incubated at the indicated temperature for 10 min before initiating reaction and assaying for the residual activity using the spectrophotometer.

Determination of heat stability

The heat stability of the sample was also determined by incubating 0.6 ml of the sample for 1 h at 30, 40, 50, 60 and 70°C respectively. 0.1ml was withdrawn at 10 min interval and assayed for residual activity. The activity at 30,40,50,60 and 70°C was expressed as a percentage of activity of the sample incubated at 30°C which was the control.

pH

The effect of the hydrogen ion concentration (pH) on the African catfish liver sample was performed according to the methods of Agboola and Okonji (2004). The sample was assayed using the following buffers of different pH values: 50 mM citrate buffer (pH 4.0-6.5), 10 mM phosphate buffer (pH 7.0-8.5), and 50 mM borate buffer (pH 9.0-11) with the aid of a pH meter.

RESULTS

Heavy Metal

The divalent metal content determined by atomic absorption spectroscopy showed that Fe had the highest concentration (11.9 ppm), followed by Ni (0.9 ppm), Mg (0.47 ppm), Mn (0.45 ppm), Zn (0.35 ppm), Ca (0.06 ppm), Cu and Co (0.00 ppm). The enzyme was also scanned across a wide range of wavelength (200-700 nm) in order to determine the presence of any peak. A sharp peak was obtained at about 406 nm which indicates the presence of divalent ions.

Effect of temperature on catfish liver

The rhodanese enzyme was assayed at temperature between 0 and 70°C. The assay mixture was first incubated at the indicated temperature for 10 min before initiating the reaction and assayed with a spectrophotometer:

A. The effect of temperature on the activity of catfish liver (Figure 4): Activity-temperature profile showing optimum temperature.
B. The Arrhenius plot of logarithm of activity against the reciprocal of incubation temperature (1/Kelvin).

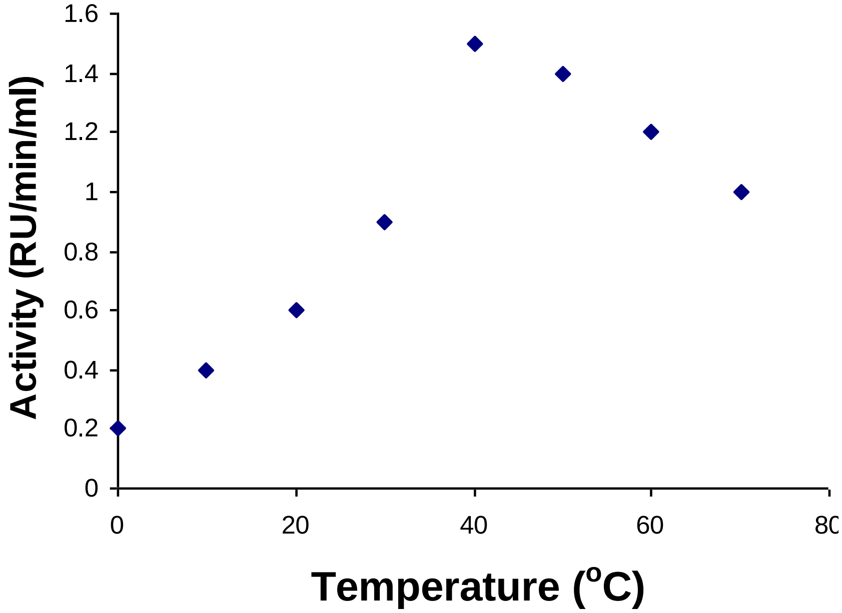

Figure 4. Activity-temperature profile showing optimum temperature.

The Arrhenius plot of catalytic activity of rhodanese consisted of two linear segments of different slopes with the larger slope at high temperatures. The temperature at which transformation (sudden break in the plot (Figure 5) occurred was 40°C. The two slopes of the plot yield apparent activation energies of 7.3 and 72.9 kcal/mol respectively.

Figure 6 shows the effect of temperature on heat stability of the liver of catfish. The activity at 30,40,50,60, and 70°C was expressed as a percentage of activity of the sample incubated at 30°C which was the control. The activity at 30°C was 100%. At 40 and 50°C, the activities were about 70 and 60% respectively and this gradually decreased with time. The activity was about 35% at 60°C and 20% at 70°C, this also decreased with time.

Effect of pH on catfish liver

The influence of pH on the rate of enzyme activity is shown in Figure 7. The enzyme activity when assayed at pH 5.0 showed no detectable increase in activity. Considerable increase in activity was obtained between pH 5.0 and 6.5, which later decreased gradually. The optimum pH was obtained at pH 6.5.

The pH optimum was determined using 50 mM citrate buffer (pH 4.0-6.5), 10 mM phosphate buffer (pH 7.0-8.5) and 50 mM borate buffer (pH 9.0-11) as shown in Figure 7. The curve represents the experimental data.

DISCUSSION

The African catfish inhabit calm waters from lakes, streams, rivers, swamps to floodplains, many of which are subject to contaminations from various sources such as effluents from manufacturing companies (Bruton, 1979; Clay, 1979). The local traditional settings around the river Osun, from which Asejire lake was built comprises mainly of fishermen and farmers. It is a common thing for cassava tubers to be steeped in the flowing river for processing into other food products. This is a major source of cyanide in this water. There are reports that fish were the most sensitive aquatic organisms to cyanide. Adverse effects on swimming and reproduction were observed between 5 and 7.2 µg free cyanide per litre; lethal effects usually occurred between 20 and 76 µg/L. Cyanide hazards to fish, wildlife, livestock and man are well documented. Massive kills of fresh water fish by accidental discharges of cyanide wastes are fairly common (Holden and Marsden, 1964; Leduc 1978; Towill et al., 1978; EPA 1980). Free cyanide is the primary toxic agent in the aquatic environment. Moreover, studies on the food composition of African catfish have shown that they are either omnivores or predators (Bruton, 1979; Clay, 1979). Micha (1973) found that African catfish feed mainly on aquatic insects, fish and higher plant debris. Some of these food items contain cyanogenic glycosides which upon hydrolysis release cyanide or hydrocyanic acid (HCN) (Wokes and Willimott, 1951; Montgomery, 1965).

This study established the presence of contaminants in Asejire Lake which in turn resulted in the contamination of the aquatics. An investigation into the presence of heavy metals in the preparations by spectrophotometric scanning and atomic absorption spectrophotometry showed a considerable concentration with Fe as the highest. This was evidenced by an absorption peak at 406 nm and the high level of Fe after its AAS metal determination experiment. These metals have a threshold in which the body can take before they will be lethal, as a

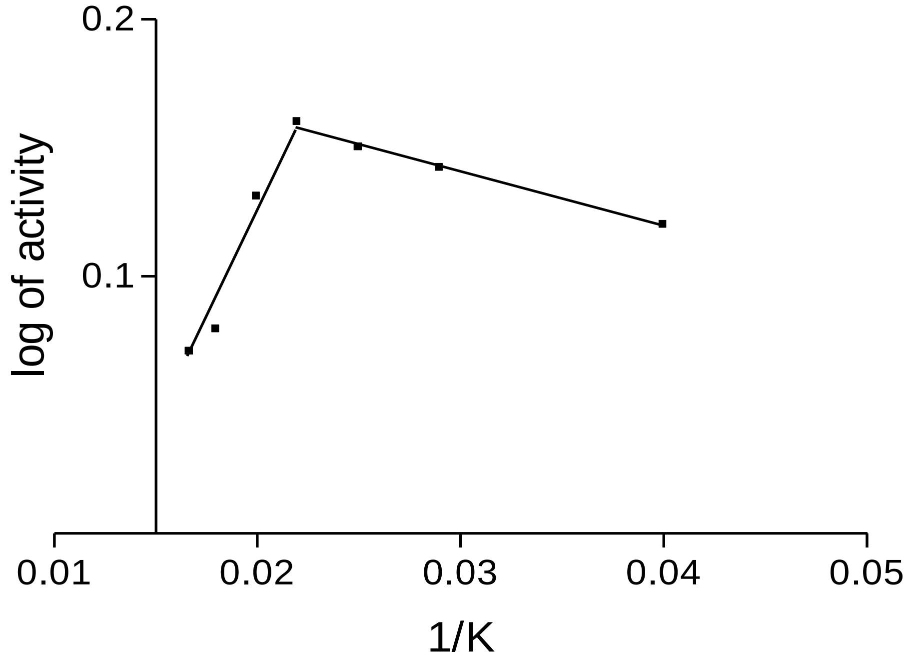

Figure 5. Arrhenius plot of logarithm of activity against the reciprocal of incubation temperature (1/Kelvin).

∆ 30°C, ● 40°C, □ 50°C, ♦ 60°C, and ○ 70°C.

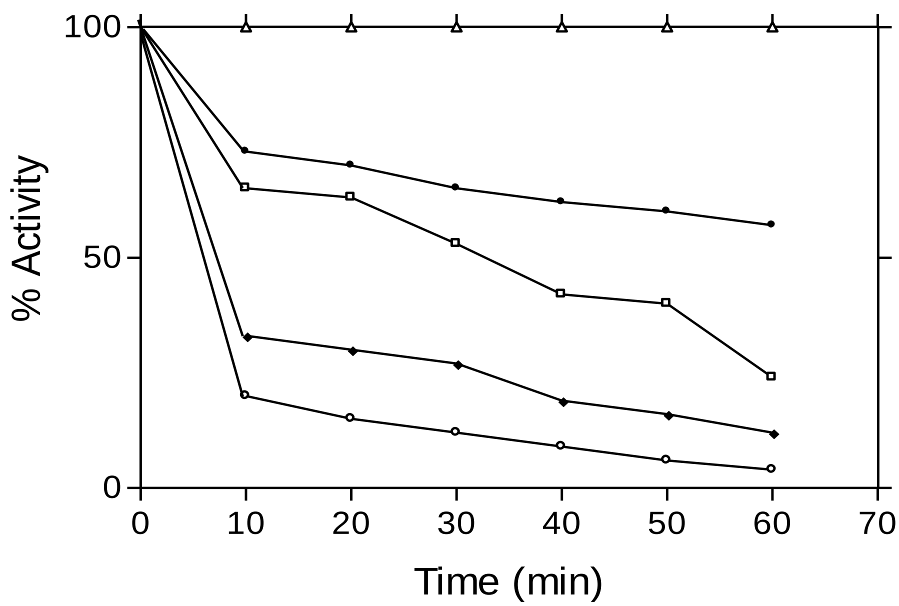

Figure 6. Effect of temperature on the stability of catfish liver.

result, accumulation and continuous consumption of these aquatics and drinking of the water can lead to coma or death.

The optimum temperature obtained was 40°C for rhodanese from the liver of the catfish from Asejire Lake. With the level of pollution in this water, there will be various metabolic activities going on in it which results in the release of heat. This ambient temperature might have conditioned the enzyme to function at higher temperatures. Arrhenius plot of effects of temperature on reaction rate

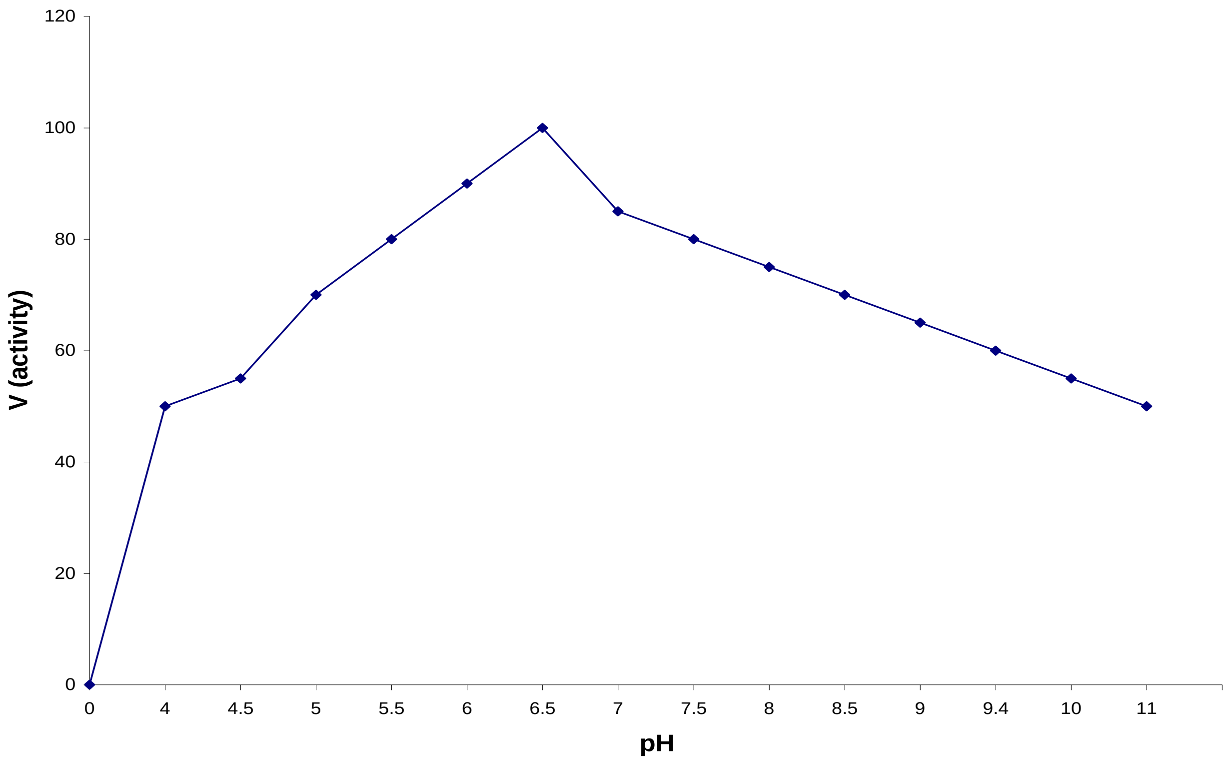

Figure 7. Effect of pH on catfish liver.

consists of two linear segments with a break occurring at 45°C. The apparent activation energy values from these slopes are 7.3 and 72.9 kcal/mol respectively.

Pollutants in water include wide spectrum of chemicals and pathogens which sometimes alters the acidity, conductivity and temperature of the water. The water sample collected from Asejire Lake showed a pH of 5.7, 6.3 and 6.5 at different points of the Lake (Lameed and Obadara, 2006). They suggested this is an indication of acidic water which might be toxic for human consumption except treated to comply with the World Health Organization recommended pH 7, for safe and drinkable water. An optimum pH of 6.5 was obtained for the liver of the catfish from Asejire Lake. This is as a result of the acidity of the water as stated above.

Conclusion and recommendation

Despite all these contamination, Asejire Lake supports various aquatics and serves the populace, the people in the environ feed on these contaminated aquatics and drink the water from the lake, the accumulation of which can lead to coma or death. The adverse effect of river pollution is the spread of water borne diseases. The uncontrolled disposal system renders surface waters and underground water systems unsafe for humans and poses a threat to human life and is therefore against the principles of sustainable development. The major goals of environmental regulation from the inception has been to reduce pollution, there have been no clearly established, coordinated policy framework and standards for attaining such goal especially through resource pricing, incentives and taxes. Rather, heavy reliance has been placed on qualitative legal rules.

Proper and adequate regulating policies will go a long way in ameliorating the hazard caused by water pollution. The advantages of clean environment would be available only if the generators of pollutants are encouraged to invest in pollution prevention and abatement technologies with the help of a judicious mix of regulatory policies, economic incentives and fiscal instruments. There is need to change the behaviour of industries/firms by selecting suitable levels of effluent charges and pollution taxes, and by supporting the industries with soft loans for investments in effluent treatment for common treatment facilities. The need to enhance proper waste management through measures that encourage minimisation, recycle and reuse of processed waste by both the industries and people involved can not be compromised. The industries /firms are to co-operate with federal, state and local governments and other relevant stakeholders in sharing emerging environmental issues, finding solutions to environmental problems and developing cost-effective, scientifically-based environmental standards. The absence of suitable national guidelines and standards on environmental pollution contributed to the high level of Asejire Lake pollution, so government should create an environmental monitoring network in other to regulate the activities of the lake pollutant. The Government should also set objectives, targets and performance standards in order to promote continual improvements in environmental management performance and the prevention of pollution.

REFERENCES

Alabaster JS (1981). Review of the state of aquatic pollution in Eastern African inland waters. CIFA Occas. Pap. 9; 36.

Ayoade AA, Fagade SO, Adebisi AA (2006). Dynamics of limnological features of two man-made lakes in relation to fish production. Afri. J. Biotech. 5(10):1013-1021.

Burgis MJ, Symoens JJ (1987). African wetlands and shallow water bodies/Zones humides etlacspeu profonds d'Afrique. Directory/Repertoire. Trav. Doc. Inst. Fr. Rech. Sci. Dév. Coop. 211, 650.

Davies B, Gasse F (1988). African wetlands and shallow water bodies/Zones humides et lacs peu profonds d'Afrique. Trav. Doc. Inst. Fr. Rech. Sci. Dév. Coop. 211, 502.

Dejoux C, Deelstra H, Wilkinson R (1981). Pollution. In: The ecology and utilization of African inland waters, UNEP Rep.Proc.Ser., 1: 149–61.

Dejoux C (1988). La pollution des eaux continentales africaines. Expérience acquise, situation actuelle et. perspective. Trav. Doc. Inst. Fr. Rech. Sci. Dév. Coop. 213, 513.

Kaur M, Singh K, Rup PJ, Kamboj SS, Saxena AK, Sharma M, Bhagat M, Sood SK, Singh J (2006). A tuber lectin from Arisaema jacquemontii Blume with anti-insect and antiproliferative properties. J Biochem. Mol. Biol. 39(4):432–440

Lameed GA, Obadara PG (2006). Eco-Development Impact of Coca-Cola Industry on Biodiversity Resources at Asejire Area, Ibadan; Nigeria. J. Fish. Int. 1(2-4), 55-62.

Olanike KA (2003). Consequences of Pollution and Degradation of Nigerian Aquatic Environment on Fisheries Resources. The Environmental. 23(4), 297-306.

Shuval HI (1986). Thalassogenic diseases. UNEP Reg.Seas Rep.Stud. 79, 44.

Stirn J (1973). Ecological consequences of marine pollution. In Proceedings of the Fifth Intérnational Colloquium on Medical Oceanography, p. 25–56.

Tolba MK (1982). Development without destruction. Evolving environmental perceptions. Dublin, Tycooly. Nat. Resour. Environ. Ser. 12, 197.