The Physico-Chemical Analysis of Water Sample from Fish Pond, Department of Animal Production Technology, Ramat Polytechnic, Maiduguri, Borno State, Nigeria

By

Peter Auta Gwaski
Rachael Hadiza Ibrahim
A. M. Bukar
The Physico-Chemical Analysis of Water Sample from Fish Pond, Department of Animal Production Technology, Ramat Polytechnic, Maiduguri, Borno State, Nigeria

Peter Auta Gwaski, Rachael Hadiza Ibrahim and A. M. Bukar

ABSTRACT

The determination of physico-chemical parameters in water sample collected from fish pond, Department of Animal Production Technology, Ramat Polytechnic, Maiduguri was conducted in June 2016. Water samples were collected at four locations established in the fish pond and homogenized to form a representative sample, then analysed using standard procedures. The metal elements of Ca, Cu, Cd, Cr, Mn, Ni, Pb and Zn of the water samples were determined by Flame Atomic Absorption Spectrophotometer. The physical parameters pH, temperature and dissolved oxygen were also determined using standard procedures. The concentration levels of metal elements in water sample were: Ca (43.40)mg/l, Cu (0.48)mg/l, Cd (0.30)mg/l, Cr (0.39)mg/l, Mn (0.11)mg/l, Ni (1.48)mg/l, Pb (0.50)mg/l and Zn (0.70)mg/l while physical parameters temperature was 28°C, pH was 6.9 and dissolved oxygen was 7.0mg/l. The results showed presence and concentration levels of all the parameters analysed. Most of the metals analysed were within the maximum levels set by WHO and NAFDAC, except Ni, Cr and Pb that exceeded the permissible limit set by WHO and NAFDAC.

Keywords: Fish pond, Water sample, Metal elements, determination and FAAS.

INTRODUCTION

The quality of any body of water is assessed by the extent of pollution of the water which may arise from domestic, industrial and agricultural wastes that eventually find their way into a body of water. Chemical pollution arising from inorganic and organic pollutants, physical pollution which includes colouration, temperature changes and biological pollution which is due to the presence of microbial agent are the three basic classification of water pollution, chemical oxygen demand (COD), biological oxygen demand (BOD, total carbon (TC), total organic carbon (TOC) levels and dissolve oxygen (DO) are parameters pertinent in determining the quality of any body of water (WHO, 1985). Ogabiela et al. (2007) specified COD, TC and TOC as organic pollutant indicators, other parameters are temperature, alkalinity (CaCO$_3$) acidity (pH), total hardness, dissolution and presence of heavy metals. Others such as corrosion, saturation index, colour, taste and odour are also included (Rodier, 1975). Many hazardous or poisonous chemical elements (heavy metals) if released into the environment accumulate in the sediment and water bodies (Begum, et al. 2005). The term heavy metals refers to any metal and metalloid element that has relative density ranging from 3.5 to 7gcm$^{-3}$ and is toxic or poisonous even at low concentration. Toxic metals are usually present in industrial, municipal and urban runoff which can be harmful to human and biotic life. Urbanization and industrialization have led to increased levels of trace metals, especially heavy metal in waterways (Ogbeibu and Ezeunara, 2000).

The contamination of fresh water in a wide range of pollution has become a matter of concern over the last decades (Nsikak, 2007). The natural aquatic system may extensively be contaminated with heavy metals released from domestic, industrial and other man-made activities which are discharged in the environment every day. These heavy metals are regarded as the most serious pollutant of the aquatic environment, because of their environmental persistence and tendency to accumulate in the body of aquatic organism (Tam and Wong, 2000). Heavy metal pollutants in surface water may pose a health risk and can be very harmful if present in drinking water and translocation to food chains. These metals disturb growth and damage the body organs, nervous system and reduce haemoglobin, leading to cancer and in extreme cases cause death of living organisms (WHO, 2003). The municipal and industrial wastes move along with agricultural drainage rapidly polluting the water bodies, causing problems of overgrowth of macrophytes and consequently leading to drastic reduction in fish production (Rodier, 1975). Water is an important solvent present in the air as water vapour and in the ground in the form of oceans, rivers, streams, ponds, lakes which cover three quarter of the earth surface and is an essential constituent of all animals and vegetable matters (Rawen et al., 2005)
Water is typically referred to as a pollutant when it is affected by anthropogenic contamination and natural disaster such as volcanoes, algae blooms, storm and earthquakes which also caused major changes in the water quality and biological status of water (Fashire, 1990). The chemical elements are essential trace elements present in water bodies which necessitate that the concentration of such elements required for healthy growth of plants, animals and other aquatic lives should be within acceptable limit that is not too low to cause deficiency and not high leading to toxicity. It is therefore necessary to monitor the levels of chemical pollutants to a level which is acceptable for human consumption. The aim of the study is to evaluate physico-chemical pollutants in water samples from agricultural fish pond, Ramat Polytechnic, Maiduguri, Borno State, Nigeria.

MATERIALS AND METHODS

Study Area

Borno state is located in the North-Eastern geographical zone of Nigeria between latitude 10° and 14°N and longitude 11°31’ and 14°45’E which lies in the sahelian vegetational belt south of the Sahara with less than 600mm of rainfall annually (World Atlas, 2005).

Sample and Sampling

The water sample for this research was collected from fish pond, Department of Animal Production Technology, Ramat Polytechnic Maiduguri, Borno State. The site was chosen because of its proximity to catchments, with activities that potentially contribute to pollution of the pond. These activities include farming using agro chemicals (herbicides, pesticides and insecticides), dumping of refuse, rearing of domestic animals and also air pollution arising due to the use of generator and incinerators around the study site.

Water Sampling

Water samples were collected from four different sampling points established in the pond in pre-cleaned plastic containers which were rinsed three times with the water sample before collection. The cleaned sample containers were dipped below the surface of the water at the depth of 20cm, then allowed to overflow for sometimes, the water samples collected were transferred into sterile plastic container and homogenized, then preserved by adding three drops of nitric acid (HNO₃) covered and labeled, then stored in a refrigerator to prevent breakdown by UV-light pending analysis.

Water Sample Preparation

Water sample collected from the study area (pond) for heavy metals determination was digested (Radojevic and Bashkin, 2006). Accurately, 100mls of the water sample was measured and carefully transferred into 250cm³ beakers and then acidified with 5cm³ conc. HNO₃. It was then heated to evaporation on a hot plate for 15 minutes until the contents reduced to 20cm³ and further acidified by adding 60ml conc. HNO₃ and 40ml conc. HC₁₀₄ in the ratio 3:2. The mixture was heated to almost clear solution. The resultant volume was allowed to cool, filtered in 100ml volumetric flask and made up to mark with distilled water. Also sample blank was prepared accordingly.

Analysis of Samples

Determinations of pH and temperature of pond water were done on site. The ELICO (Cl513) digital pH meter was calibrated using buffers of pH 4.0, 7.0 and 10.0 for the determination of pH. Also, glass bulb mercury thermometer was calibrated by a two phase system tests using ice water at 0°C.

Determination of Dissolved Oxygen (DO)

A portable Griffin oxygen meter model M-40 was used for measuring the dissolved oxygen ‘DO’ of water on the site. The analyzer was switched on and allowed to warm up for 5 minutes. The electrode was then immersed into 5% W/V sodium sulphate solution and then read out was allowed to stabilize and zero setting knobs were adjusted to zero. The electrode was removed from the solution, cleaned with distilled water, dried and span calibrated. The dissolved oxygen (DO) for the water sample was measured by dipping the electrode directly in the water body (pond) and the meter was set to read the dissolved oxygen.
Determination of Heavy Metals in the Water Sample

The standard method of flame atomic absorption spectrophotometer (FAAS) was employed for determining the heavy metals analytes (Ca, Cd, Cr, Cu, Pb, Mn, Ni and Zn) as described by Vogel (2000) and SC (2000). The Shimadzu Atomic Absorption Spectrophotometer AA-6800 operational with a ASC-6100 auto sampler and air acetylene atomization gas mixture system was used for the analysis.

RESULTS AND DISCUSSIONS

Results

Table 1.0: showed values of some physical parameters of water sample

| Parameters      | Value   | WHO 1996 Standard |
|-----------------|---------|--------------------|
| pH              | 6.90    | 6.5 – 9.5          |
| Temperature     | 28°C    | -                  |
| Dissolved Oxygen| 7.0mg/l | 7.0mg/l            |

Table 2.0: showed concentration levels of some elements of water samples

| Parameters | Value     | WHO 1996 Standard |
|-----------|-----------|--------------------|
| Ca        | 43.40     | 75-200             |
| Cd        | 0.30      | 0.003              |
| Cr        | 0.39      | 0.05               |
| Cu        | 0.48      | 1.0 – 1.5          |
| Pb        | 0.50      | 0.05 – 0.1         |
| Mn        | 0.11      | 0.3 – 0.5          |
| Ni        | 1.48      | 0.02               |
| Zn        | 0.70      | 5.0 – 15           |

DISCUSSIONS

The results of physical parameters are presented in Table 1.0. The pH value observed for the sample was 6.90, this value was within the permissible levels of WHO (6.50 – 9.50) and NAFDAC (6.50 – 8.50). pH values lower than 6.50 can lead to corrosion of pipes causing release of metals like Zn, Pb and Cu in water. Also, high pH value above 6.50 can lead to increase scale formation in heating vessels and reduce bactericidal effect of chlorine in drinking water (Manjula et al. 2011). The temperature was 28°C, this parameter is one of the most important parameters for aquatic environment because almost all the physical, chemical and biochemical processes are temperature dependent (Akande et al. 1992). Dissolved oxygen is also a parameter which is vital to aquatic lives; both plants and animals, which relied on them for their survival in ponds and lakes (Radwan et al. 2003; Ana et al. 2012). The results of dissolve oxygen (DO) in the pond for the period under study exceeds the minimum dissolve oxygen standard of 5mg/l which is in agreement with that of Peter et al. (2013). The high level of dissolved oxygen may be attributed to stratification as a result of water's temperature dependent density, implying that cold water can hold more dissolved oxygen than warm water.

The results as presented in Table 2.0 revealed high concentrations of Ca (43.40)mg/l, Ni (1.48)mg/l, Zn (0.70)mg/l, Pb (0.50)mg/l, Cu (0.48)mg/l, Cr (0.39)mg/l, Cd (0.30)mg/l and Mn (0.11)mg/l which is the least value. The concentration of calcium, 43.40mg/l was below the limit of 75mg/l (WHO, 1987). Calcium (Ca), though a determinant of hardness of water also functions as pH stabilizer and gives water a better taste (Garcia, 2002). Similarly, Nickel (Ni) which is the second highest metal element of concentration 1.48mg/l is above the recommended limit of 0.02mg/l, small quantity of nickel (Ni) is essential, but when taken in excess can be dangerous to human health (Goyer and Clarkson, 2001).

The results of the analysis showed that the concentrations of the metals determined in the water sample of the fish pond were in the order Ca>Ni>Zn>Pb>Cu>Cr>Mn. Zinc has been reported to cause the same signs of illness as lead does and can easily be mistakenly diagnosed as lead poisoning (Monbeshora et al. 1982). Lead also presented value of 0.5mg/l as against the recommended value of 0.05mg/l. Lead is very toxic and is a common heavy metal contaminant which get into the water from corrosion of plumbing material sources, including paints, mining wastes, incinerators and automobile exhaust to water lead pipe and solder used to join copper pipes (Wilson, 1990). These vast sources of this metal may be responsible for its high level in the sample. Copper (Cu) when taken in excess may be toxic and can cause vomiting, diarrhea and loss of strength. However, in long term, the toxicity can cause liver damage, kidney failure and ultimately death while short term effect can lead to gastrointestinal distress (Al-Rashed and Spangle, 1971). Chromium which has a value of
0.39mg/l as compared to its lower limit of 0.05mg/l is a mineral element needed in small amount for normal body function, such as digestion of food (Zhang, 2007). Drinking water supplies chromium to the body and also cooking in stainless steel cookware supplies chromium content in food (Beliza, 2008). However, when chromium supplement is taken in excess could lead to stomach problems and low blood sugar and subsequently cause irregular heart rhythm (Fasmire, 1990). Cadmium element which has concentration of 0.30mg/l compared to its recommended limit of 0.003mg/l gets into the water body through its origin which include electroplating, corrosion of natural deposition discharge from metals and refineries, battery and paint wastes, mining as well as sewage (Ross, 1994). The vast sources of this metal may be responsible for its high level of this investigated sample and also due to dumping and application of fertilizers which is very close to the pond (Study site) and contribute to its higher value. Manganese which is the least presented a scaring value of 0.11mg/l as against the recommended limit of 0.3mg/l. However, its deficiency may result to abnormal skeletal development in a number of animal species. Generally, heavy metals make significant contributions to environmental pollutions as a result of anthropogenic activities which include intensive agricultural practices, power transmission, sludge and industrial effluents, dumping of refuse and military operations (Foy, 1978). Base on the results of the analysis the concentration levels of all the parameters determined were below the permissible limit set by WHO except Cd, Cr, Pb and Ni which exceed the permissible limit which are cause for concern.

CONCLUSION

It is indeed difficult to judge about the degree of long term pollution and water quantity from short period measurements such as the results presented in this work which were based only on a portion of the fish pond on assessment of a short period of measurement. However, an overall summation of the quality status of the fish pond from this assessment revealed a somewhat healthy state of the aquatic lives especially in terms of temperature and pH parameters.

Crucial for consideration is the status of some heavy metals (Cd, Cr, Pb and Ni) indicated as beyond the permissible limits as at the time of this study. These poses threat to the quality of water in the fish pond. Thus, it is evident from this that the fish pond is posed with a number of adverse factors emanating from the continual applications of agrochemicals for farming, dumping of refuse, rearing of domestic animals and other practices around the fish pond in terms of the quality of aquatic environment.

REFERENCES

Al-Rashed, R.A. and Spangler, J. (1971). Copper deficiency in man. Medical Intelligence N. Engl. J. Med. 285:841-843.

Akande, O.R., Eyo, A.A. and Adelowo, E.O. (1992). Quality Changes in canned tilapia stored at ambient and Accelerated Temperature. Proceedings of the 10th Annual conference of the Fisheries Society of Nigeria, Abeokuta 16-20th November, 62-74.

Ana, J.G.S., Bileynnie, P.E. Reheema, M.A. Escultor Archilles, R. dela Cruz (2012). Water quality report on Calibato Lake 1996-2005. Environmental Quality Management Division (EQMD) Rizal, 15-27

Begum, A., Amin, M.N. Kaneco, S. Onta, K. (2005). Selected elemental composition of the muscle tissue of three species of fish, tilapia nilotica, cirrhina miraga and clarius batrachus from the freshwater Dhanmondi lake in Bangladesh. Food Chemistry, 93: 43-443.

Beliza, R. (2008). Detoxification mechanism of lead, identification of lead in water.

Fashire, G.J. (1990). “Zinc toxicity”. Am. J. Clin. Nut. 51: pp.225-227.

Foy, J.J. (1978). Heavy metals Review. The Nig. J. Pharm. 37: 41-45.

Garcia, S. (2002). A copper-responsive transcription factors, CFFI, mediates copper and cadmium resistance in Yarrowia lipolytica. J. Biol. Chem. 277(40): 59-68.

Manjula, A.V., Shankar, G.K.R. and Sharada, M. (2011). Bacteriological Analysis of drinking Water samples. Journal of Bioscience and Technology 2(1): 220-222.

Monbeshora, C., Osibanjo, O. and Ajayi, S.O. (1982). Pollution studies in Nigeria Rivers: The onset of lead pollution of surface water in Ibadan. Environmental International 9(2): 81-84.

Nsikak, U.B., Joseph, P.E. Akan, B.W. and David, E.B. (2007). Mercury accumulation in fishes from tropical aquatic ecosystem in the Niger-Delta. Environmental International 9: 781-785

Peter, A.G., Stephen, S.H. Naomi, P.N. and Victor, O.O. (2013). Modeling parameters of oxygen demand in the Aquatic Environment of Lake Chad for depletion Estimation 1(3): 116-123.

Ogabiela, E.E., Ajunwa, U.B. Lawal, F.A. and Awoeye, L.D. (2007). Analysis of tannery effluents from the confluence of discharge point at Sharada Industrial Estate in Kano, Nigeria Journal of Chemical Soc. of Nigeria: 32(2):17-19.

Goyer, R.A. and Clarkson, E. (2001). Toxic effect of metals. In: Cararentt and Doullis Toxicology: Basic Science of Poison, 6th Ed. (C.D. Klassen, Ed). New York: McGraw Hill, pp. 811-867.
Ogbeibu, A.E. and Ezeunara, A. (2002). Hard application of chemically-treated sewage sludge III. Effects on soil and plants heavy metal content. J. Environ. Qual. 9: 264-273.
Radojevic, M. and Bashkin, V.N. (2006). Practical environmental analysis (2nd Ed.) RSC Publishing, U.K. pp. 248-257.
Rawen, M., Willems, P. El-Sadck, A. and Berlamount, J. (2005). Modelling of dissolve oxygen and biochemical oxygen demand in river water using a detailed and a simplified model. Int'l. J. River Basin Management 1(2): 99-103.
Rodier, P. (1975). Hazardous chemicals in human and environmental health. A Resource Book for School, College and University Students, 3rd Edition
Ross, J.A. (1994). The impact of heavy metal pollutants on human and animals when consumed. Vol. 2.
SC, Shimadzu Corporation (2000). Atomic Absorption Spectrometry Cookbook. Food Analysis, Analytical Instruments Division, Kyoto Japan, G10, 1-32.
Tam, N.E.Y. and Wong, Y.S. (2000). Spatial variation of heavy metals in surface water and sediments of Hong Kong mangrove Swamps. Environ. Poll. ILO: 612-622.
Vogel, A.I. (2000). Textbook of Quantitative chemical Analysis (6th Edn). Revised by Mendham J. Donney, R.C., Barnes, J.D., Thomas M.J.K. Pearson Edu. Ltd. India, 104-107, 602-607.
WHO (1985). Guidelines for drinking water quality (II). Health criteria and supporting information. WHO, Geneva, Switzerland.
WHO (1987). Principles for the safety assessment of chemicals in Food International Programme on chemical Safety. Wid. Org. Geneva, EHC 70.
WHO (1996). Water quality assessment. A guide to use of biota sediments, p. 36
WHO (2003). Sulphate in drinking water, Background document for preparation of WHO Guidelines for Drinking Water Quality. Geneva WHO 03-04/p.4
Wilson, J. and Memahon, R. (1990). Effect of high environmental copper concentration on the oxygen consumption, condition in water, comparative biochemistry and physiology 70C: 139-147.
World Atlas (2005). Physical map of Africa. http://www.encartamap/20.africa
Zhang, C.C. (2007). Fundamentals of environmental sampling and analysis. John Wiley and Sons Inc. Hoboken, New Jersey pp. 127-155

Cite this Article: Gwaski PA, Ibrahim RH and Bukar AM (2017). The Physico-Chemical Analysis of Water Sample from Fish Pond, Department of Animal Production Technology, Ramat Polytechnic, Maiduguri, Borno State, Nigeria. 2(1): 001-005, http://doi.org/10.15580/GJCST.2017.1.111517166