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Assessment of domestic wastewater on the quality parameters of a fish pond

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Abstract

This study takes a look at the effect of the refuse dump on the Karu stream in Karu, Nasarawa State of Nigeria used to service fish ponds. There may be atmospheric pollution that is transferred to the water body by setting, by direct absorption or by runoff and other precipitations. The reference point for identifying and assessing pollution is the impact it has on human being is of interest. Samples were taken at points before the domestic waste concentration, Point of Refuse Concentration, Mid-Point and Point of Leaving along the stream. The pH value obtained ranged between 7.78 and 7.97 at the Control Point, Point of Refuse Concentration, Middle Point and Point Leaving respectively. The temperature at these various points ranged between 30 and 32^{0}C The quantity of suspended solids ranged between 124-359, the colour ranges between 60 and 137, alkalinity had a range between 192 and 420, The quantity of suspended and dissolved solid of the stream was noticed to increase from CP to PL whose values ranged from 124-359.

Keywords: environmental pollution, fish, fish pond, parameters, quality

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Introduction

Environmental pollution and its associated problems are not new; they have been in existence on earth since the beginning of time. This is seen as the discharge by man of substances or energy into the environment which results into hazards against human health and causes harm to the living resource and to the aquatic ecosystem or organisms. However, with time, satisfactory treatment and disposal of waste depends ultimately upon the development and employment of efficient low cost process, and the enforcement of effective legislation. There is need for a nation to show great concern for the disposal of its society's waste product in a safe and environmentally acceptable manner. The increasing demand for environmental protection through regulated environmental standards ought to force industries in Nigeria to re-evaluate the economic impact of the environmental issues and adopt new cost effective approaches to waste management (Musa et al., 2013). In the vicinity of industrial plants, there may be atmospheric pollution that is transferred to the water body by direct absorption or runoff. Examples of pollutions so transferred are dust from cement factories and smelters, acids and chemicals from chemical manufacturing plants, sulphur dioxide and acids from smelters and phenotic chemicals from coke quench towers (Goñi-Urriza et al., 2000).

Sangodoyin (1991) stated that, domestic, agricultural, municipal and industrial water demands are growing rapidly throughout the developing world under the combined effects of population growth, burgeoning industry and urbanization. In order to satisfy the yearning for water supply, exploration of all avenues to convert all available water to use and tapping of ground water at random by all has become paramount. Transfer or unfavourable releases from domestic and industrial plants through settlement, direct absorption, or runoff into the water body may be detrimental to human health, safety, welfare or human properties and resources, organisms, hindrance to aquatic activities including fishing impairment of quality of water used in the domestic, industrial, agricultural or recreational areas and reduction of amenities.

River water quality could be expected to vary with season and flow. In recent times, certain cultural and technical practices have been adopted to increase ground water storage, one of such being the utilization of surface runoff. Such practices are based on the realization that ground water emerging into surface stream channels could help in sustaining stream flow when surface runoff is low and non-existent (Todd, 2006). Based on observation of the interaction between ground and surface water flow, Glover and Balmer (1954) gave an empirical relationship which identified soil permeability, aquifer thickness, distance between well and stream, storage coefficient and time of pumping as principal variables.

Generally, the reference point for identifying and assessing pollution is the impact it has on human interest, and hence the need for the assessment of the effect of domestic and industrial effluents on surface and ground water pollution as it is in Karu-site stream area of Abuja. The level of water quality is relatively dependent on the ultimate use to which the water will be put. Once the natural, physical, chemical, and biological condition is affected, however, the water is said to be polluted (Wilber, 1969). Over the years, both theoretical and experimental works have identified various sources of pollution of surface and ground water viz-a-viz organic waste from sewage, water weeds, synthetic chemicals and mineral substances, sediments, radio-active pollution and temperature increase and bad waste management. The adverse impact on the environment is largely due to indiscriminate and unregulated exploitation of both renewable and non-renewable resources and the use and the abuse of environment as a sink for dumping waste products of development activities. The objective of this study is to determine the impact of domestic waste on surface water, by comparing the results obtained with standard water quality for fish pond and what major control measures are required for the water quality to be maintained.

Study area and data collection: Description of study area

Abuja located within the geographical region of the guinea savannah on Latitude 9° 4' 60 N and Longitude 7° 31' 60 E. Karu town is located at the eastern boundary of Abuja with a population of about 800,000 of which a very high proportion work in Abuja city. Karu, is built to house the capital's civil servants and lower income families, thus placing it within the region of high demand of urban expansion while on the other hand, its benefits from increased activity.

Data collection

Samples of water were taken from four different points of 80 meters before the point of domestic waste concentration (Control Point, CP), point of refuse concentration (PRC), another sample was collected midpoint (MP) of the stream and finally at the point of leaving (PL). The Mid Point (MP) is the point between the PRC and the PL. The MP which is 60 meters from PRC and 50 meters to PL Point of Leaving. The samples were collected using 1 li container and transported to the laboratory on ice in cooler boxes. The samples were collected every three weeks over a period of two months during the dry season as described or reported by Fatoki et al. (2001). Sample containers were labelled according to the various points of collection. Using the standards of ANON (2000), APHA (1998), WHO (1993) the following parameters were determined: pH, temperature, total alkalinity, hardness, calcium ion (concentration), chloride, nitrate, sulphate, iron, manganese, turbidity, dissolved oxygen and colour.

Results and Discussion

The results obtained from the stream characteristic at the Control Point (CP), Point of Refuse Concentration (PRC), Middle Point (MP) and the Point of Leaving (PL) is shown in Table 1. The quantity of hydrogen ions (H^+) in water determines the acidic or basic nature of water. The acceptable range for fish culture is normally between pH 5 – 9.0. The pH at Control Point was 7.78 while at PRC, MP and PL were 7.91, 7.95 and 7.97 respectively which shows that at the Mid-Point the value of pH increases towards the Point of Leaving. This increase from the Mid-Point is due to the refuse dump into the stream as there is a mini refuse dump site at a point before the Point of Leaving. This is in conformity with the works of Alam and AL-Hafedh (2006). However, when the result for the values of pH were compared with those of the standards required for the survival of fish, it was discovered that the values were within the permissible limits of the standards. Thus, indicating that fishes can survive in this stream. Hence, creating a good condition for the development of a fish pond around the Karu stream. Since the samples were collected during the dry season at the Control Point of the stream, the water was clear in physical appearance. At the PRC due to the refuse disposed, the stream colour was cloudy which basically is as a result of the decomposition of the refuse. A mini water fall outlook is present between the PRC and MP by the gentle slope nature of the stream and this is responsible for the rapid velocity increase of the stream water and in turn responsible for the turbulence produced at this point which may equally affect the colour of the water.

The colour units began to reduce due to the gentle movement of water beyond the Mid-Point which may be because of some sedimentation taking place along the stream. The stream exhibited self-purification characteristics and at the Point of Leaving, the clear nature of the stream returned. The colour at CP, PRC, MP and PL were 60, 156, 137 and 90 respectively. The variation observed in the temperature ranged between 30 and 32^0C was highly influenced due to the peak summer during February and April. When these results were compared with the works of Ayanwale et al. (2012); Mmochi et al. (2002), the differences observed was not of great margin though they obtained values were within the permissible range of 25 and 32^0C for the survival as recommended by Wen-Cheng et al. (2005).

Table 1. Average physicochemical properties of Karu stream

Parameters	Units	Point of collection of sample with specified distance				FEPA
		CP (0 m)	PRC (80 m)	MP (140 m)	PL (220 m)	Standard
pH		7.78	7.91	7.95	7.97	5 - 9
Colour (HU)	HU	60	156	137	90	NS
Turbidity (NTU)	NTU	20	35	20	20	1.00 - 150.00
Temperature	0C	30	31	32	32	20 - 35
Ec	(µohms/cm)	185	501	402	395	20 -1500
Total Dissolved Solid	mg/L	124	193	296	359	NS
Total Suspended Solid	mg/L	56	110	93	81	NS
BOD	mg/L	1.8	2.95	2.89	2.76	10 - 20
DO	mg/L	15	15.1	17	17	> 1.00
COD	mg/L	15.71	55.7	24.6	23.8	NS
Total Alkalinity	mg/L	24	28	22	29	10 - 400
Magnesium Hardness	mg/L	3.7	1.65	1.97	1.48	NS
Calcium Hardness	mg/L	80	186	116	64	NS
Total Hardness	mg/L	117	351	213	112	NS
Iron	mg/L	0.5	2.6	1.2	0.8	NS
Manganse	mg/L	0.03	0.14	0.14	0.12	NS
Chloride	mg/L	11.2	14.7	11.1	10.9	NS
Nitrate	mg/L	2.3	2.5	2.7	2.3	NS
Phosphate (PO_4)	mg/L	1.8	1.9	2.1	2	0.01 - 3.00

Where Control Point (CP), Point of Refuse Concentration (PRC), Middle Point (MP), the Point of Leaving (PL) and Not Stated (NS)

The electrical conductivity values obtained from the points where samples were collected ranged between 185 and 501 µohms/cm. For fishes to survive under any condition, the recommended value by the Federal Environmental Protection Agency ranges between 20 and 1500 µohms/cm. This result was similar to the works of Ehiagbonare and Ogunrinde (2010). The quantity of total suspended and total dissolved solid of the stream ranged between 56 and 110 mg/L; 124 and 359 mg/L respectively. It was noticed that the total dissolved solids increased from CP to PL. This basically is due to the presence of refuse dump site and direct dumping of domestic waste into the stream which increased the solid content of the stream. This phenomenon could be responsible for the foul smell produced by the stream. Though the results obtained were similar to the works of Ehiagbonare and Ogunrinde (2010). Swann (1990) stated that alkalinity is the capacity of water to neutralize acids without an increase in pH. This parameter is a measure of the bases, bicarbonates (HCO_3^-), carbonates (CO_3^-) and in rare instances hydroxide (OH^-). The alkalinity level at CP, PRC, MP and PL were 24, 28, 22 and 29 respectively. This sharp reduction could be as a result of dilution effect of the stream's self-purification characteristics. This further shows that the level of alkalinity in the stream is within the limits when compared with recommended standard for the survival of fishes; that the fish farmer maintains a total alkalinity value ranged between 10 and 400 mg/L. For water supplies that have naturally low alkalinities, agriculture lime can be added to increase the buffering capacity of the water.

Hardness is chiefly a measure of calcium and magnesium but other ions such as aluminum, iron, manganese, strontium, zinc, and hydrogen ions are also included. When the hardness level is equal to the combined carbonate and bicarbonate alkalinity, it is referred to as carbonate hardness. Hardness values greater than the sum of the carbonate and bicarbonate alkalinity are referred to as non-carbonated hardness. The total hardness is lower than the level of alkalinity which is an indication that the stream also contains less of some other metallic ions aside calcium and magnesium. However, Table 1 indicates a high content of calcium and magnesium at PRC and MP respectively. Direct discharge of effluents by some households may be responsible for this. The results obtained from the Karu stream showed that at CP the total hardness was 117 mg/L with a sudden sharp increase at PRC to 351 mg/L; at MP it reduced to 213 mg/L while at PL it further reduced to 112 mg/L which also show that the stream has been under going through some form of self-purification. The chloride content at PRC was 14.7 mg/L which is higher when compared to the other points while PL had the lowest at 10.9 mg/L meaning that the domestic effluent discharge into the stream at PRC was high which the actual point of refuse dump is. The water had been diluted before PL, the site of refuse and direct dumping would not allow more than 2 mg/l reduction at PL to give 10.9 mg/L.

The major source of nitrate into the stream is from the surrounding farm lands which are applied to the crops grown on the bank of the stream as fertilizer. The value of nitrate ranged from 2.3 to 2.7 mg/L. The entrance of domestic effluents and refuse site downstream has increased the presence of nitrates at MP of the stream especially from the point of refuse dump. However, the reduction is due to self-purification of the river as it moves downward with the assistance of dilution as it continuously flows. Phosphate, like the nitrate are essentially required by living organisms, however it can be considered a pollutant if present in high concentrations under specific environmental conditions. The values of phosphate ranged between 1.8 and 2.1 mg/L. This is by far the most important chemical parameter in aquaculture. Low-dissolved oxygen levels are responsible for death of most fishes, either directly or indirectly, than any other problems combined. Like humans, fish require oxygen for respiration. The amount of oxygen consumed by the fish is a function of its size, feeding rate, activity level, and temperature. The DO values ranged between 15 and 17 mg/L.

There are various activities that may result in increasing production of DO and this include turbulence and increase in flow velocity and this activities result in re-aeration of the liquid. This phenomenon is made possible due to the fact that there is a gentle slope outlook present at the location of the Karu site stream. Manganese is essential for nutrition in both human and animals. The values from the result obtained are 0.03, 0.14, 0.14, and 0.12 mg/L from the CP, PRC, MP, and PL of the stream respectively. The proposed objective value of manganese by WHO (1993) is 0.01 mg/L and maximum acceptable limit is 0.05 mg/L. The manganese content of the river was observed to be above the required limit which could be as a result of discharged effluents into the stream by some of the household's settler within the area. From the result obtained it is shown that at the CP, BOD is 1.80 mg/L which increased at PRC, 2.95 mg/L and later reduces from

MP to PL, 2.89 and 2.76 mg/L respectively. This might be the reason for high microbial activities at the PRC than at CP and then lesser of the microbial activities from MP to PL as the stream flows along. The oxygen required for chemical changes during oxidation process of the organic matter in the water body may be produced through this process. At the Point of Refuse Concentration (PRC) to the Point of Leaving (PL) the result shows a reduction in COD. This is due to the reduction of chemical reacting substances in water during self-purification process as the stream is in a continuous flow.

Conclusion

The quality of water depends on the purpose which the water serves or is intended to serve. Although consideration of multiple use frequently arise in practice. Surface water intended for abstraction of drinking water, affluent and wastewaters, irrigation water, water for animals, fresh water for bathing, amenity waters and indeed marine water are subjects to quality standards. However, classification of the trace elements into essential, non-essential and toxic group can be inaccurate and misleading as all the essential elements can become toxic at sufficiently high intakes. With this important dose at the back of the mind, one can easily deduce that the presence of most of these elements and radicals in high quality especially at the point of concentration of refuse dump always dictates pollution. The result of the sampled stream indicated that most part of the streams showed that the parameters were relatively low compared with the standards of FEPA. Thus, some variety of fishes can survive. Also, from the result it can be deduced that disposal of refuse dumps along stream areas should not be encouraged especially disposal of domestic and industrial waste generated by those staying around the areas of the stream. The water from the sampled stream shows some concentrated amount of major domestic pollutants as most pollution characteristics exist in adequate quality. It is however reasonable to treat the water from the stream before use. In general, there is a pollution of ground and surface waters due to the presence of trace elements, inorganic substances in the water. The degree of pollution as presented by this study is not too serious as a clear evidence of self-purification and other water (stream) dilation is exhibited downstream.

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