MPRI-JAVS | INTERNATIONAL JOURNAL OF AGRICULTURAL AND VETERINARY SCIENCE
VOL. 02 NO. 1 OCT-2023 ISSN: 1115 – 831X

ASSESSMENT OF POND WATER QUALITY FOR FISH CULTURE IN GWALLAMEJI AREA OF BAUCHI, BAUCHI STATE

SAGIR A.Y; MUHAMMAD S.; BABA B.; & BUKATA Y. G.
Department of Civil Engineering, Abubakar Tatari Ali Polytechnic Bauchi

Abstract

This study deals with the assessment of pond water quality for fish culture by measuring various physicochemical parameters of water for fish culture from the three identified ponds situated at Gwallameji Area of Bauchi State. The parameters including temperature, Ph, DO, BOD, appearance, TDS, EC, colour, ammonia, total hardness, total coliform and fecal coliform were investigated on 3 ponds in Gwallameji, the obtained values of the investigated parameters were temperature 23.3 – 23.7°C, Ph 6.5 – 8.5, DO (nill), BOD (nill), appearance (unobjectionable), EC 120 - 440µs/cm, total hardness 150mg/l, total coliform 150cuf/100ml, fecal coliform 0cfu/100ml. All the values were compared with the water quality standards for fish culture. The comparative analysis showed that most of the water quality parameters of the 3 ponds were suitable for fish culture while the temperatures recorded were higher in most cases than the desired level, and appearance were also fluctuated highly. From this investigation, it is recommended that necessary steps should be undertaken to improve the water quality of the ponds to a suitable level for fish culture. Steps should be implemented in such a way that they do not ensure high yield fish production only, but also bring about economic benefit and also conserve environmental quality effectively.

Keywords: Pond, Water Quality, Fish Culture, Gwallameji

Introduction

Water is the culture environment for fish where they perform all their bodily functions. They are totally dependent upon water to breathe, feed and grow, excrete wastes, maintain a salt balance, and reproduce (Bookmark

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

and Hansson, 2020). Water quality focuses on the various aspects of the physiochemical parameters of water by which state of a water body can easily be observed. It is the first most important limiting factor in fish culture which is normally governed by a number of parameters including color, odor, temperature, Ph, DO, BOD, TDS, EC, transparency, acidity, alkalinity and hardness (Boyd, 2019). Each of these parameters has a standard value for fish culture (James, 2019). A guiding principle of fish culture is that water quality enhances efficient production and a direct consequence of good water chemistry (Swann, 2020). Therefore, the maintenance of good water quality is essential for healthy fish culture. The majority of fish culture throughout the world is conducted in ponds. Pond habitats can easily be manipulated by controlling the water characteristics for an optimum environment yielding high level fish production (Swann, 2019). It also has a great impact on the production of farm products as the waste water is very rish in phosphorus, nitrogen and potassium (British journal, 2019). The chemistry of natural surface water is complex, and depends on the equilibrium reached with the normal physical, chemical and biological characteristics of the surrounding environment. Thus, there can never be a normal surface water quality; every natural water would have a different composition.

Even rainwater varies in composition in different localities and regions, this can be due to the atmospheric inversion as affected by the green house. The precipitated water droplets will absorb acidic ions, volatile chemicals and fine particulate matter of natural and anthropology-genie origin. A substantial proportion of the nitrogen input to soils comes with the winter rainfall (Mostapha S.K 2021). Recent data have shown that the level of atrazine in rain can be as high as $1\mu g1^{-1}$ in areas where there is widespread use of this herbicide.

Rain that falls on soil overlying granite rock will tend to remain acidic and the run-off will be a soft water, low in calcium and bicarbonate. Water draining from areas of peat bogs will also be acidic, and can be extremely so with sudden rainfall after a prolonged dry period. Water with a low pH (<5.0) will dissolve naturally occurring metals from the soils and rocks, especially aluminum and in some areas copper, zinc and lead. Soft waters may be clear, or brown with varying amounts of dissolved humid substances. Water falling on soil overlying chalk and limestone will become alkaline with hardness depending on the amount of dissolved calcium and bicarbonate that it contains (Abees, 2019).

To some extent the surface water quality will depend on the type of vegetation covering the watershed, since the products of plant decay (as with the peat bogs mentioned above) will find their way into the streams draining the area. Water draining from coniferous forests tends to be acidic (Richard 2020).

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

INTERNATIONAL JOURNAL – AVS
VOL. 02 NO. 1 OCT-2023 ISSN: 1115 – 831X

Apart from affecting the suspended mineral solids content of the water, these physical changes have little effect on the chemical quality of the water. However, they can affect the natural biological community that can live in equilibrium with the particular chemical and physical characteristics of their environment, and changes in the composition of the aquatic biota can also affect the water quality.

The most obvious effects are those caused by increased plant growth. Clearly, rooted plants 'will provide shade and cover for a wide range of aquatic species. But all green plants, including algae, photosynthesize during their period of growth in the daylight hours, and respire at all times. During daylight, plants absorbed carbon dioxide from the water and this is converted to carbohydrate; dissolved oxygen is produced and this is released into the water (British Journal 2020).

When plant growth is active, these photosynthetic processes are more pronounced than that of respiration, in which dissolved oxygen is absorbed and carbon dioxide is released. As a result, the pH of the water is raised during the day as the amount of carbolıc acid is reduced, the dissolved oxygen concentrations are also raised during the day. At night, the level of carbon dioxide increases, leading to a lower pH, and the level of dissolved oxygen falls (Molyd, 2020).

These fluctuations of dissolved gas concentrations are natural and normal, but they can be accentuated by, for example, an increase in the plant nutrients as a result of fertilizer run-off from arable land which can cause excessive weed growth. Also, the discharge of readily biodegradable organic wastes can increase the amplitude of the fluctuations (Suzan R. 2019).

Therefore, the quality of surface water is never constant; it is constantly changing in response to daily, seasonal and climatic rhythms. Organisms, including fish, in a particular water-body can adapt to these natural fluctuations of water quality (including temperature) as they occur.

Natural causes and man activities are the major causes of differences in water quality. Metal mining, by increasing the surface area of exposed rock to rainfall, can cause elevated concentrations of metals in drainage water. Commercial forestry can cause an increase in suspended mineral solids in the water after areas have been cleared by cutting and logging.

Intensive agriculture can also contribute fertilizers and pesticides applied to arable crops, and strong organic liquids can be produced from silage manufacture and from the rearing of poultry and cattle. Hence weaker organic wastes, both in much greater volumes, can be discharged in the form of untreated or treated sewage leading to the degradation of the aqua life (fish farming). Thus the present study aims at investigating the physicochemical parameters of pond water and comparing the analyzed values with the standard values for fish culture.

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

INTERNATIONAL JOURNAL – AVS
VOL. 02 NO. 1 OCT-2023 ISSN: 1115 – 831X

A Brief Review of Adaptive Mechanism in Fish Respiration

Fish obtained the oxygen that they require for their metabolic processes from the gas dissolved in water. The solubility of oxygen in water is low and depends on the temperature; at 5, 15 and 25°C. The dissolved oxygen concentration is 12.8, 10.0 and 8.4 mg per liter respectively. These amounts are those for water in equilibrium with air, and are known as air saturation values. They will vary slightly with changes in barometric pressure. The saturation value for oxygen per sea is about five times that of the air equilibrium value (Newton S.U.et 2020).

Because of this low concentration of dissolved oxygen in water, the fish has to have an extensive and efficient respiratory mechanism. Water flows through a sieve of parallel plates; each plate, or secondary lamella, consists of a central sheet of pillar cells with concave sides that form blood spaces. These cells are covered by a thin epithelium. Oxygen diffuses from the water across the epithelial cells and the extensions of the pillar cells into the blood space. To increase the efficiency further, the blood lows in the opposite direction to the water flow. This counter-current arrangement enables the almost fully utilized water of low oxygen content to come into close contact with (venous) blood with a low partial pressure of oxygen (Alonso et al., 2019).

At the same time, carbon dioxide diffuses from the blood into inter lamella space. Again, the counter current flows maximize the diffusion gradients, which may be enhanced still-further by the presence of the enzyme carbohydrate at the gill surface, which converts some of the gaseous CO_2, to carbolic acid. When a fish is inactive, the respiratory apparatus is more than sufficient to supply the necessary amount of oxygen to the blood. Under such conditions, only a proportion of the Secondary lamella may be utilized for respiration, and the concentration of red blood cells may be reduced. The latter may assist the heart in that it will reduce the viscosity of the blood being pumped through the gill capillaries before then passing via the arteries to the capillaries of the various tissues (Etal A.Y.J 2020).

In response to a high energy demand, or a low concentration of dissolved oxygen in the water, the fish can respond in two ways: the blood flow can be increased by opening up further secondary lamella to increase the effective respiratory area (it may be difficult to increase significantly the blood. flow rate through the capillaries themselves). And the concentration of red blood corpuscles can be increased to raise the oxygen carrying capacity of the blood per unit volume. The latter can be achieved by reducing the blood plasma volume (e.g. by increasing the urine flow rate) in the short term, and by releasing extra blood corpuscles from the spleen in the longer term (M.Y. Boyd 201 8). At the same time, the ventilation rate is increased to bring more

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

water into contact with the gills within a unit time. There are, however, limits on the increased flow attainable: the space between the secondary lamella is narrow (in throat it is about 20um) and water will tend to be forced past the tips of the primary lamella when the respiratory water flow is high, thus by-passing the respiratory surfaces (A.J. Austin 2021).

These reactions are quite adequate to compensate for the normal fluctuations of energy demands of the fish and of dissolved oxygen concentrations the water. One of -the consequences, however, of an increased ventilation rate is that there will be an increase in the amount of toxic substances in the water reaching the gill surface where they can be absorbed (Boyd 2020).

Osmoregulation

Because the osmotic pressure of the body fluids of fish is considerably higher than that of freshwater, there will be a continuous influx of water across the Surface epithelium and a corresponding loss of ions into the water (Jamee Y. 2020). These fluxes occur over the whole body surface, but particularly at the gills which are relatively unprotected in this respect. Elsewhere, fluxes can be relatively high in the fins, but the remainder of the body is protected by a tough epithelium (and usually scales) and a covering of mucus. The influx of water balanced by a copious discharge of urine, from which as much sodium and chloride as possible has been re-absorbed in the kidneys. These organs do not control the osmotic pressure of the internal fluids: such control is exerted by special cells in the gill epithelium, whereby sodium is taken up in exchange for hydrogen ions, and chloride in exchange for bicarbonate (James, 2021). The internal hydrogen and bicarbonate is derived from respiratory carbon dioxide in the blood (B.J. 2019). It is clear that damage to the integument, the fins, the ability to secrete mucus or its removal from the body surface, will lead to an osmotic imbalance. Similarly, damage to the gill epithelium will affect the ability of the fish to control their internal osmotic pressure.

Toxic substances in the water

It is not the purpose of this document to deal with this aspect of adaptation in any depth. The following brief summary describes the salient features. Fish have become genetically adapted to live in such diverse environments as cold, soft, arctic waters to warm muddy rivers in the tropics. Transfer of fish between these environments is not possible. In the same way, there is a limited potential for genetic adaption to extreme conditions within a particular environment: for example, to extreme acidity in waters affected by acid rain, or to elevated levels of zinc in waters affected by historic mining activities (Flix, 2020).

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

In general, however, most of the adaptations that do occur are due to the limited ability of individual fish to detoxify the harmful chemicals entering the body, e.g. by enhancing the biochemical processes involved. For example, high levels of ammonia in the water are toxic to fish; however, the end-product of protein catabolism in fish is ammonia which is excreted by the gills (Janet Smith 2021). A limited adaptation to ammonia can be obtained by enhancing the excretory mechanism. Similarly, elevated levels of zinc and copper in the water can be harmful, although at lower levels they are essential elements for fish. The internal concentrations of these metals are maintained by trans-locating them as complexes with metallothionein (proteins) and perhaps by depositing surplus metals in the form of inert granules. These mechanisms can be enhanced to a certain extent to cope with limited increased metal levels in the surrounding water (Wakim jon et al., 2019). Many organic compounds can be metabolized and detoxified in the liver; residues can be excreted in the urine or via the bile through the gut. Again, there is a limited capacity for these mechanisms to become enhanced to cope with increased uptake of potentially harmful chemicals from the water. The existence of such mechanism can be demonstrated by placing fish which have been exposed to sub-lethal concentrations of a toxic-ant into higher concentrations and comparing their survival times with those not previously exposed. In general, it is unusual to find that fish can achieve more than a four-fold increase in resistance to a toxic substance (Sudys Yassyn 2020).

METHODOLOGY

The study was conducted on six (6) selected ponds at Gwallamaje area of Bauchi state. The following tests were conducted: water quality test, physical constituents test, chemical constituents test and biological constituents test.

RESULTS

Colour and odor

The colour of the investigated pond water is observed visually. The colour of study pond 1 was found to vary from light to deep green and colour of pond 2 ranged from brown to gray. The deep green colour represents higher planktons and light green colour represents lower planktons. According to (Das, 1997), a well and phytoplankton enriched water body appears to be dark greenish blue, or red or brown. The odour of the investigated pond water was smelt by nose. The odour of pond 1, 2 were fishy and odour of pond 3 was not fishy. The odour of an ideal pond water is not fishy or odourless (Das, 1997).

Temperature

The range of temperature were from 23.7, 23.3, 23.3, in P1 (Pond 1), P2, P3 respectively.

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

INTERNATIONAL JOURNAL – AVS
VOL. 02 NO. 1 OCT-2023 ISSN: 1115 – 831X

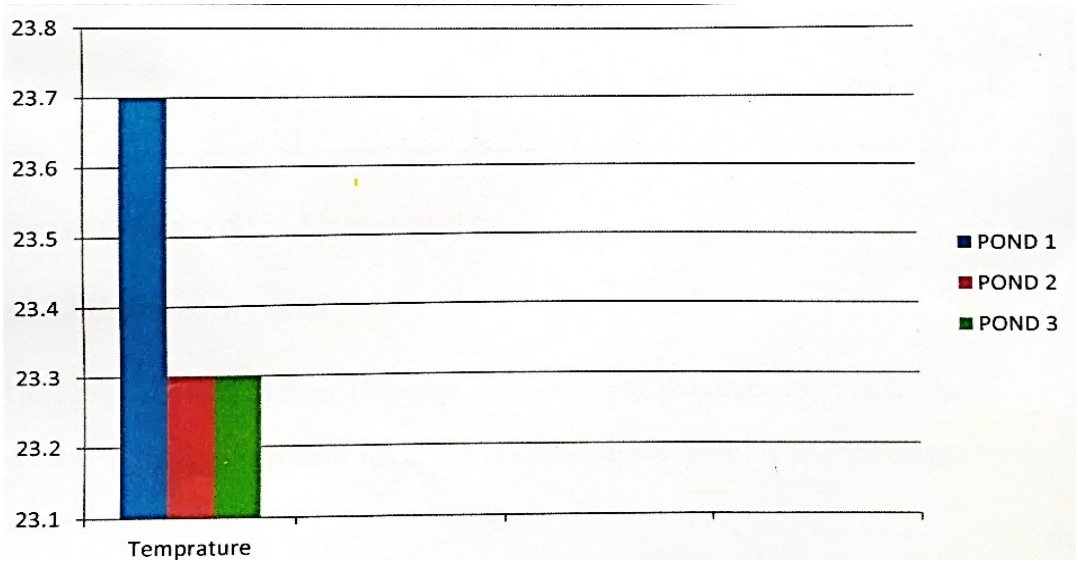

Fig. 1: Average values of temperature in 3 investigated ponds

For freshwater aquaculture the suitable range of temperature is about 25-320C. while 22-240C for ponds (Das, 1997). In the present study, temperature recorded at all ponds were suitable within the time of sampling, the values were found not to exceed the suitable range.

PH

The PH values in P1, P2, and P3 fluctuated from 6.5, 6.9 and 6.6 respectively with an ambient value of 6.5-8.5 (Fig. 2).

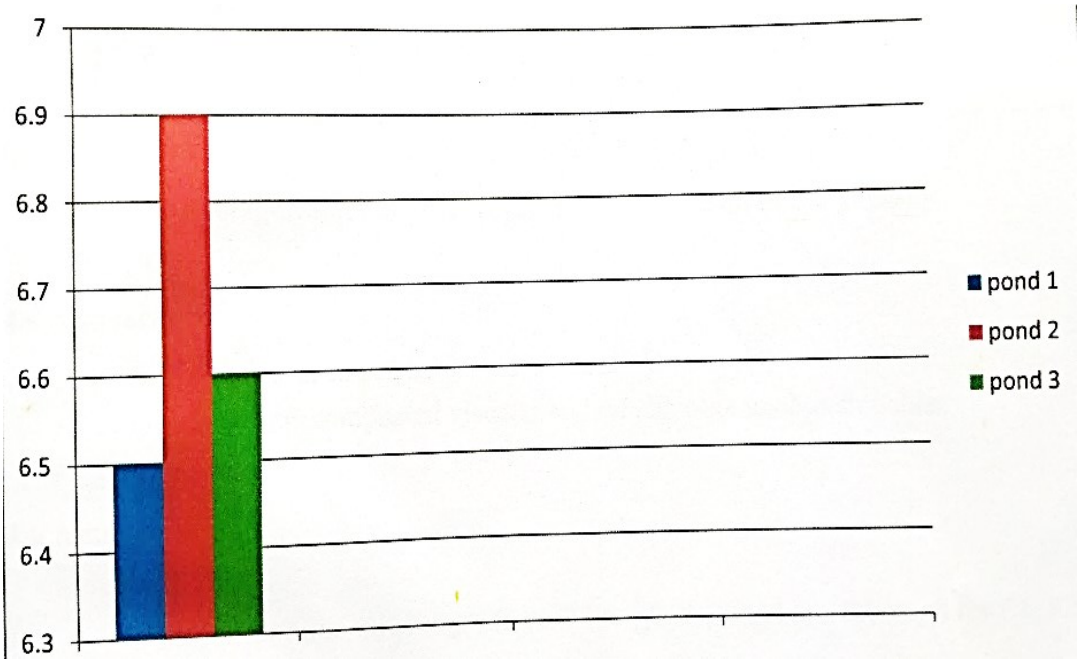

Fig. 2: Average values of pH in 3 investigated ponds.

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

INTERNATIONAL JOURNAL – AVS
VOL. 02 NO. 1 OCT-2023 ISSN: 1115 – 831X

Electrical Conductivity (EC)

The EC values ranged from 120µs/cm, 440µs/cm and 320µs/cm, in P1, P2, P3, respectively (Fig. 3). Meanwhile the standard electrical conductivity in pond ranges from 125µs/cm to 350µs/cm.

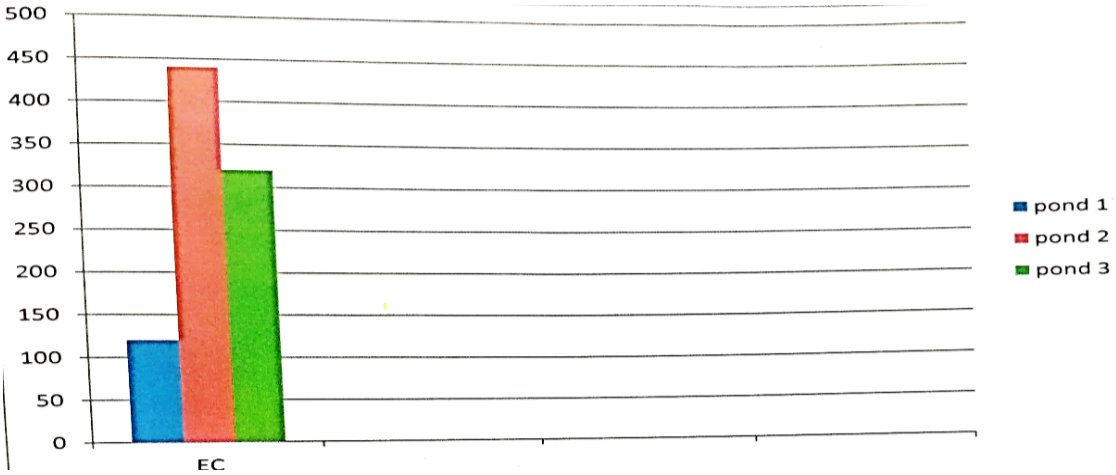

Fig. 3: Average values of electric conductivity in 3 investigated ponds

Appearance

Appearance was compacted visually and results were unobjectionable.

Ammonia

The values for ammonia from 0.00mg/1, 0.13mg/l and 0.00mg/l for P1, P2, P3 respectively (Fig. 4). Meanwhile the standard value of ammonia in fish pond 0.00mg/l parts per million (ppm).

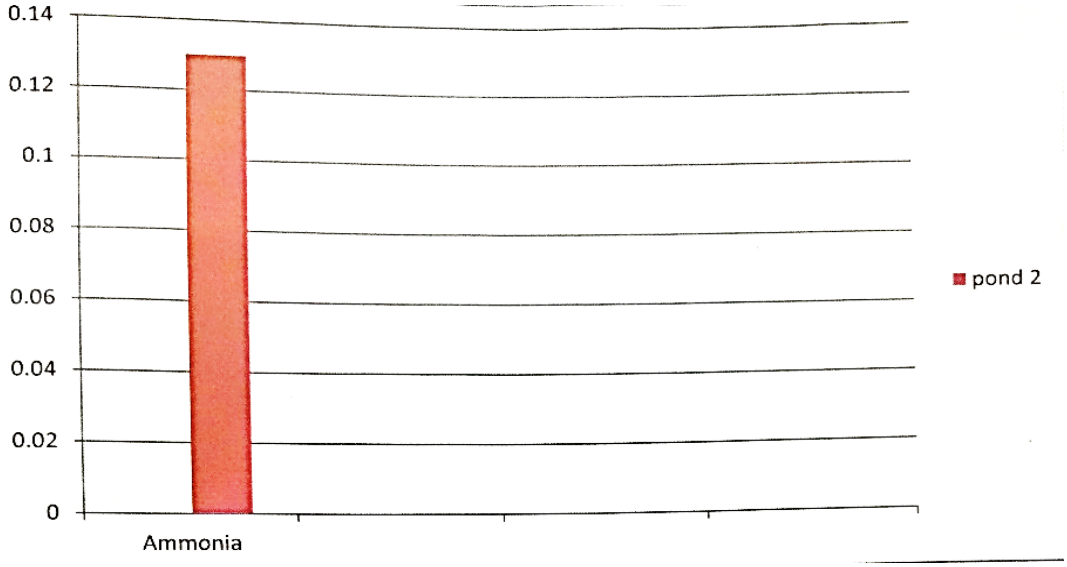

Fig. 4: Average value of ammonia in 3 investigated pond

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

INTERNATIONAL JOURNAL – AVS
VOL. 02 NO. 1 OCT-2023 ISSN: 1115 – 831X

Turbidity

The values of turbidity ranges from 11.8NTU, 7.58NTU and 4.29NTU with an ambient value of 5NTU for P1, P2, P3 respectively (Fig. 5).



Fig. 5: Average value of turbidity in 3 investigated pond

Total Hardness

The values of hardness ranges from 40mg/l, 152mg/l and 112mg/l for P1, P2, and P3 respectively (Fig. 6). Meanwhile the standard value ranges from 20mg/l to 300mg/l.

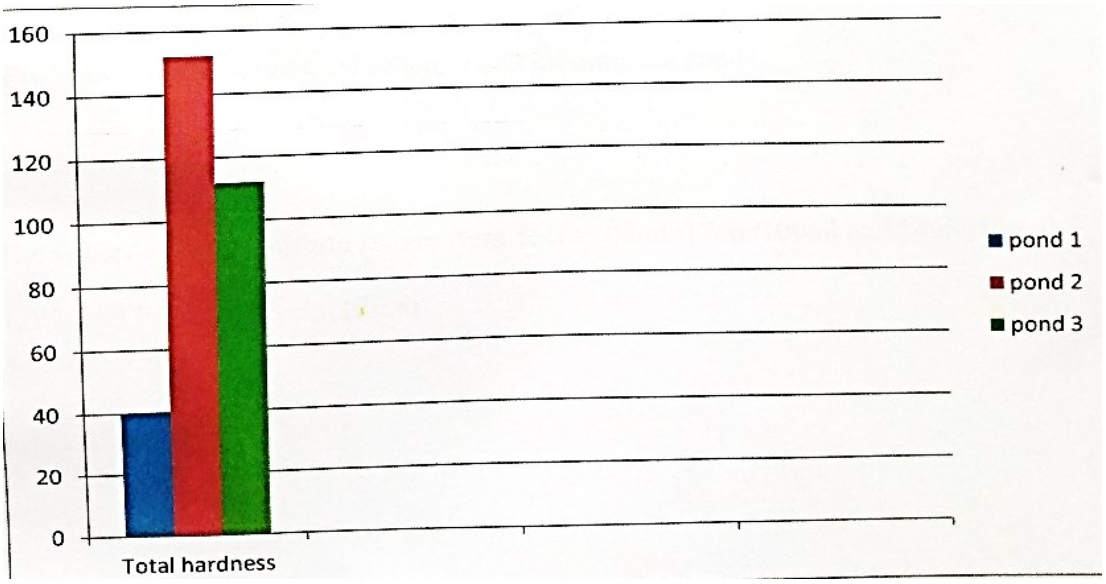

Fig. 6: Average value of total hardness of 3 investigated ponds

Total Coliform

The values for total coliform ranges from 103cfu/100ml, 35cfu/100ml, and 89cfu/100ml with an ambient value of 10cfu/100ml. (fig. 7).

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

INTERNATIONAL JOURNAL – AVS
VOL. 02 NO. 1 OCT-2023 ISSN: 1115 – 831X

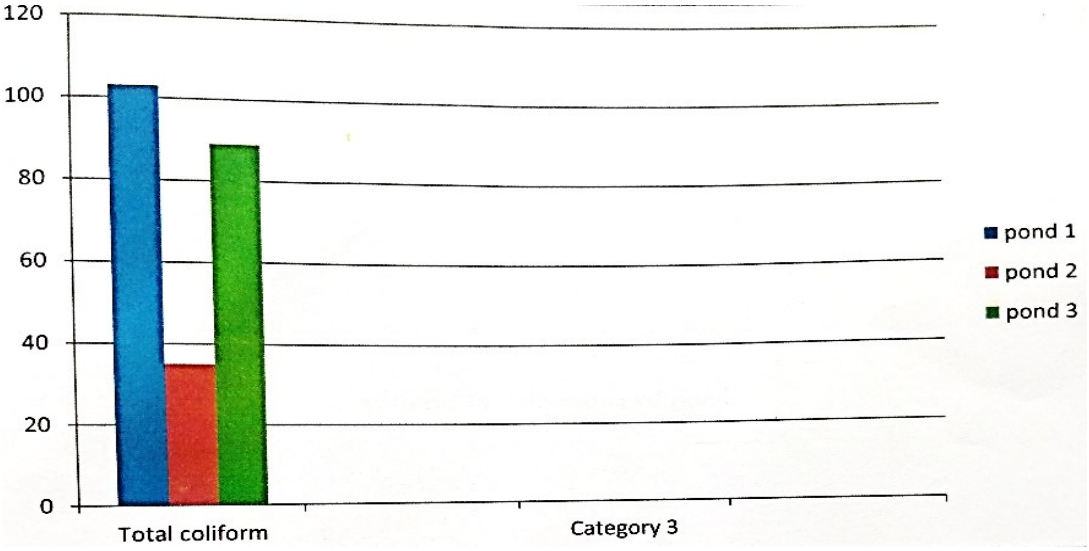

Fig. 7: Average value of total coliform in 3 investigated ponds

Fecal Coliform

The values of fecal coliform ranges from 56cfu/100ml, 17cfu/100ml, and 14cfu/100ml in P1, P2, and P3 respectively (fig. 8).

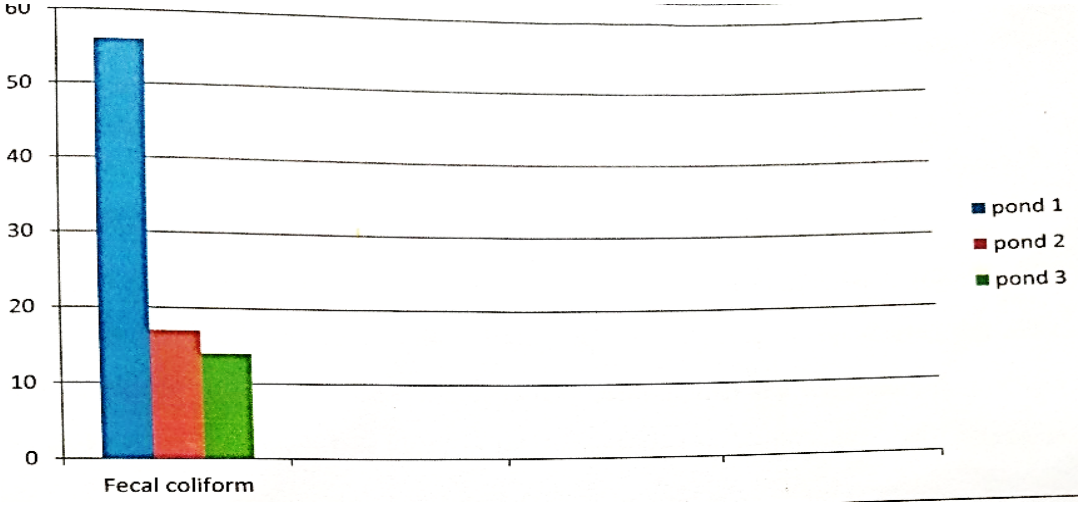

Fig. 8: Average value of fecal coliform in 3 investigated pond

CONCLUSION

The present research was conducted to assess the pond water quality for fish culture in Gwallameii, Bauchi local government area. The average values of pH, appearance EC, total hardness, total coliform and fecal coliform of all the investigated ponds (pH 6.5-8.5, BOD (nil), EC 120-440 us/cm, total hardness 150 mg/, appearance unobjectionable, total coliform 10cuf 00ml and fecal coliform 0cfu/100ml) were acceptable for pond fish culture while the temperature and transparency recorded

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

from all of the ponds were lower than the desired level. The mean Do (dissolved oxygen) and BOD (biochemical oxygen demand) values of water were not computed for due to lack of reagents to carry out tests. The ranges of TDS values (85-164 mg/l) from all the study ponds were very lower than the standard value.

RECOMMENDATIONS

The present study recommended some proper steps to be undertaken at the investigated ponds to maintain and improve the water quality for fish culture:

i. Pond water quality should be monitored regularly to enhance the productivity of fish;
ii. Discharge of effluents into pond water should be stopped to control pollution;
iii. Pond water surface should be agitated with bamboo poles or by swimming to increase DO level;
iv. Proper fertilization should be ensured to maintain TDS and transparency level:

REFERENCES

Boyd, C.E. (1990). Water quality in ponds for aquaculture. Alabama agricultural experiment station, Auburn University, Ala.

Bronmark, C. and Hansson, L.A. (2005). The biology of lakes and ponds. Oxford University Press. Oxford, 285p.

Das, B. (1997). Fisheries and fisheries Resources management, Bangla Academy, Dhaka. Bngladesh, 153-155. DoE Standards, 2004. The People's Republic of Bangladesh.

EQS (Environmental Quality Standard), (1997). Bangladesh Gazette, registered nr.DA-1, Ministry of Environment, Government of Bangladesh.

James, M.E. (2000). Water Quality and recalculating aquaculture systems. Aquaculture systems technologies, LLC, New Orleans, LA, 16-17p, 28p.

Swann, LaDon, (1993). Water sources used in aquaculture. Illinois-Indiana Sea Grant Program. AS-486. Purde University, West Lafayette, IN. 4p.

Swingle, H.S. (1967). Standardization of chemical analysis for waters and pond mud. FAO Fish Rep., 4(44): 397-421p.

Forsberg, J.A. P.W. Dorsett, and W.H. Neill, (1996). Survival and growth of red drum scianeopsocellatusin saline groundwaters of West Texas, USA. Journal of the World Aquaculture Society, 27: 462-474.

Piper, R.G., I.B. McElwain, L.E. Orme, J.P. McCraren, L.G. Flower, and J.R. Leonard (1982). Fish hatchery management, U.S. fish and wildlife service, Washington DC.

Scheffer, P.M. and L.D. Marriage (1969). Trout farming, U.S. Soil conservation service, Washington DC. Leaflet 552.

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

Thurston, R.V. R.C. Russo, and K. Emerson, (1979). Aqueous ammonia equilibrium tabulation of percent un-ionized ammonia. Environmental Research Laboratory Duluth, U.S. Environmental Protection Agency, Duluth, Minnesota, EPA-600/3-79-091.

USDA (U.S. Department of Agriculture) (1996). Aquaculture outlook. U.S. Department of Agriculture, Economic Research Service, Washington, D.C. Report LDP-AQS-4, October 8, 1996. (Samson, 2019).

Yoo, K.H. and C. Boyd, (1993). Hydrology and water supply for pond aquaculture. Wiley and Sons, Inc., New York.

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]