AnaleleUniversităţii din Craiova, seriaAgricultură – Montanologie – Cadastru (Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series)Vol. 51/2/2021

THE QUALITY OF THE AQUATIC ENVIRONMENT IN FISH PONDS

VOICEA I.[1], DUMITRU D. [1], VLĂDUȚ V. [1], PETRE A.[1], NENCIU F.[1], MOGA C.I. [2]
[1]INMA Bucharest / Romania, [2]SC DFR Systems SRL,
E-mail: voicea_iulian@yahoo.com

Keywords: aquaculture, fish, ecological environment.

ABSTRACT

In our country, the most widespread growth system is the semi-intensive one with growth units represented by ponds (anthropogenic ecosystems). The semi-intensive fish culture is based on the natural productivity and / or enriched by fertilization of the anthropogenic ecosystems, respectively also on the administration of supplementary food. In fact, semi-intensive cultivation involves obtaining a fish biomass with low production costs due to the use of inexpensive inputs. The productionprofile and the way of obtaining it determine the structure and duration oftheexploitation cycle within a fish farm.

INTRODUCTION

The pond, the basic functional unit of a systematic fishing arrangement, represents a temporary aquatic ecosystem, the duration of its flooding being determined by the role played by it in the technological process. As an aquatic ecosystem, the pond must be thought, through the concept of intended development, as a unit organizational structure consisting of a biotope occupied by a biocenosis, which is capable of achieving biological productivity.

Biotoperepresents the abiotic component of the ecosystem and has as constituent elements the substrate, water and mineral suspensions. The biotope is characterized by **external factors** (geografici, climatici, antropici etc) also **internal factors**(geological structure of the substrate and physico-chemical parameters of the substrate and water).[1]

With the exception of geographical factors (latitude and altitude), the other abiotic factors have fluctuating values between certain limits. Variations that have a certain periodicity and amplitude have a regime character. Regime variations determine the adaptation of biocenoses in the pond to local conditions, within the limits of species tolerance to a certain factor. There are in a biotope also accidental variations in frequency and amplitude of abiotic factors, a situation in which these factors become limiting and influence in a direct way and in a relatively short period of time the population structure of the biocenosis.

Substrate or bentalit is characterized by its pedological structure, nature, thickness and physico-chemical properties of sediments. The permanent interaction between water and substrate determines the concentration of mineral elements in the water mass, a concentration that expresses, at a given moment, a more or less stable balance of the environmental conditions in the pond. A rich microfauna develops on the sediments, consisting of autotrophic bacteria (chemosynthesizing), saprophytic heterotrophs (nitrifying and denitrifying), as well as benthic flora and fauna, important links of the trophic chain in the basin.

Water is the main component of aquatic biotopes. It is the environment in which life appears, organizes and develops. The existence of biocenoses, their diversity and the level of biological productivity of the pond depend primarily on water quality. The water is in a permanent and complex correlation with the bental. The bental and the pelagial form a unitary environment that must fully satisfy the ecotechnological exigencies of the cultivated species. In relation to the biocenosis of the ecosystem, water is manifested by influencing factors that act accidentally or permanently (with regime character) and that can have a positive or tolerant effect, and in certain situations, limiting or lethal.The level of productivity of aquatic ecosystems depends largely on the physico-chemical qualities of the water and the substrate (soil).[2]

The indicators for assessing the quality of water and soil are numerous, the most relevant in establishing the bioproductive capacity of an aquatic ecosystem and in substantiating the exploitation technology within a fishery arrangement being: temperature; dissolved oxygen content; pH; salinity; carbon dioxide; alkalinity; total hardness; mineral acidity; ammonium; nitrites; hydrogen sulfide; methane; phosphorus; nitrogen; organic matter; pesticides; heavy metals.

Physical properties of water.

Temperature,through regime fluctuations and in correlation with other factors, directly and indirectly, determines the rhythm of bioactivities, the structure of biocenoses and biological productivity in aquatic ecosystems. Most fish species in Romanian waters are eurytherme, withstanding variations in water temperature in the range 2÷30°C. During the winter, most fish species reduce their biological activity, and with the warming of the water, the metabolism is activated, doubling at each interval of 10°C. The heating process determines the thermal stratification of the water vertically, registering noticeable differences between the temperature at the water surface and the one near the bottom of the pond.

This explains the situation when the carp survives at temperatures of 34°C recorded on the surface of the water, taking refuge in the deep, micro-depression areas of the pond, provided that there is sufficient oxygen dissolved in the water. The possibilities to intervene in case of excessive water heating are, for economic reasons, limited. The gradient of the vertical thermal stratification of the water determines the variability of the technologically optimal water depths, which are necessary within a pond, where a certain technology is applied, with a certain degree of intensity.[3]

Pisces are more difficult than other living things to withstand sudden changes in temperature, the higher the sensitivity the lower the age category. As such, the highest losses caused by thermal shock are recorded during the incubation period and in the early stages of development after hatching.

The instability of the water temperature during the winter causes significant losses, which are even greater the younger the fish and the lower the fat reserves.

Water temperature affects the process of respiration, feeding, metabolism, growth, behavior, reproduction of all fish species, as well as rates of detoxification and bioaccumulation.

In addition, temperature plays an important role in controlling the distribution of feed, for the reason that fish are animals of variable body temperature and consume the more food the higher their body temperature. When the water temperature is lower than 13°C it was found that the distribution of feed in the ponds with edible fish does not give any results. Theoretically it is estimated that an increase in temperature with 10°C it doubles and even triples the amount of feed.

The turbidity of water is given by solids dissolved or suspended in the mass of water. The sources of suspended solids are plankton, manure, uneaten food or clay particles suspended in water. Suspended solid particles are large particles that deposit over time causing clogging of canals and water basins. Clay particles, on the other hand, are an exception to the rule. The clay particles remain suspended due to the associated negative electrostatic charges. Water turbidity caused by phytoplankton and zooplankton has no direct adverse effects on the fish population. Phytoplankton not only produces oxygen, but also acts as food for zooplankton and fish or crustacean species that use the filtration method for feeding. Phytoplankton also uses ammonia produced by fish as a nutrient source. Zooplankton are an important source of food for small fish or juvenile fish. However, excessive amounts of algae can intensify the breathing process during the night and, consequently, increase the consumption of dissolved oxygen. Excessive increase in phytoplankton mass or the "flowering" phenomenon of water, which will later succumb, will also consume a large amount of oxygen. Any significant change in dissolved oxygen levels between night and day can result in a dangerous decrease in oxygen concentrations.[4]

During fish production, high concentrations of suspended or sedimentable solids occur. Fish manure is a major source of water quality reduction as it contains up to 70% of the total amount of nitrogen. The disturbance caused by clay or soil particles, however, can limit the degree of light penetrability and thus restrict photosynthesis. Sedimentation of soil particles can also suffocate deposited eggs and can destroy beneficial microbiological communities that inhabit the bottom of basins (certain colonies of bacteria). One way to reduce the disturbance is to use materials to which clay particles that have a negative electrostatic charge can be attached, thus forming particles heavy enough to settle. The most used methods are the immersion of hay bales (approx. 17-25 bales of hay per hectare of basin) or the distribution of about 750-1250 kg of quicklime / ha. The second method, using lime, can be repeated at interval of two weeks if a satisfactory result of water clarification has not been obtained.

Transparency *(cm)* and water color. Water transparency is a physical property dependent, among other things, on the thickness of the water layer penetrated by the sun's rays, the amount of suspensions and their nature, the terrain configuration, the amount of light entering the water, the structure of the pool hearth, etc. relative to the natural productivity of a fish pond. A water with high transparency denotes its poverty in natural food, while a lower transparency, associated with a greenish or blue-green color, indicates a medium or even high natural productivity.[5]

MATERIAL AND METHOD

Chemical properties of water.

Dissolved oxygen. It is one of the most critical limiting factors. The solubility of oxygen in water depends on temperature, atmospheric pressure and salinity (Table 4). Oxygen may come from diffusion from atmospheric air, but this pathway is ineffective in ponds where the process of photosynthesis due to phytoplankton is intense. In this sense, it was calculated and established that the oxygen intake due to photosynthesis can be 5 - 20 mg / l, and that due to diffusion in the air is 1 - 5 mg / l. different organisms in the water and the diffusion of water in the air. Thus, the respiration of plankton registers values of 5-15 mg / l, the respiration of fish 2-6 mg / l, the respiration of benthic organisms 1-3 mg / l, and the water-air diffusion 1-5 mg / l. It turns out that the oxygen supply will occur only during the day and will record the highest values in the afternoon and at the water surface, where the phenomenon of photosynthesis is most active.

The overcast sky causes poor photosynthetic activity and reduced oxygen to extinction if the days without sun repeat. The phenomenon of water flowering determines the reduction of oxygen, by the decomposition of dead algae that fall on the bottom of the pond. Oxygen does not recover until after the algae population has recovered, starting from the surface to the bottom of the water. The bottom of the pond is in anoxia for a few more days. The danger is increased in case of excessive surface water heating, when the anoxia on the bottom prevents the fish from taking refuge in the deeper area with lower temperature and in case of strong winds that cause the mixture of bottom waters without oxygen, quantitatively dominant, quantitatively dominant, with the surface ones, finally leading to the disappearance of oxygen in the pond.[6]

The minimum water-soluble oxygen requirement for most fish is low and the lower lethal threshold is sometimes below 1 mg / l, as follows:

(crucian, 0,1-2,0 mg/l O_2;carp, 0,2-0,8 mg/l O_2;reaper, 0,2-0,6 mg/l O_2;head carp, 0,3-1,1 mg/l O_2.)

Research has shown that at low values of 0-0.3 mg / l, some fish can survive if the duration of exposure is short. Lethal threshold limits for fish range from 0-1 mg / l. Survival is possible and growth is weak between the limits of 1.0-5.1 mg / l O2; between 1.0 - 5.0 mg / l, with permanent exposure, there is also an increased susceptibility to diseases and a higher level of food conversion. Normal growth conditions are achieved when oxygen exceeds 5 mg / l; between 3-3.5 mg the carp refuses food and moves to the area with richer O_2.

Oxygen during the night under water flowering conditions is reduced to a minimum in the morning in carp ponds.

Large amounts of oxygen are required for trout. The optimal value of oxygen in the feed water must correspond to the saturation of 90-100%, ie 9-11 mg / l; at evacuation it must not fall below 60%. In any case, the minimum oxygen required to grow trout is 6 mg / l. The oxygen requirement for smaller trout (less than 50g) is 500-600 mg / kg / hour, and for larger ones 400-500 mg / kg / hour. From here it results that at a water flow of at least 1 l / sec you can grow 50kg larger trout.

Lack of oxygen is externalized primarily by respiratory deficiency. O2 consumption in carp is influenced by temperature; a 100 g carp consumes 17 mg to 10^{o}C, 31 mg to 15^{o}C, 50 mg to 20^{o}C, 72 mg to 25^{o}C and 105 mg O_2/kg/oră to 30^{o}C. It is very important that in the hatching phase, the water saturation in O_2not to be lower than 80%, otherwise it will lead to embryo death or loss at the beginning of larval enlargement.In conclusion, it can be said that in general, there is an interdependence between O2 levels in water and food, characterized by the fact that the consumption of oxygen by fish per unit weight increases with the amount of feed distributed. The administered feeds, on the other hand, cause an influx of manure of the fishes, which in the transformation process that it undergoes in the pond laboratory, contributes to the reduction of the amount of oxygen in the water.

In dangerous times, the fish farmer must know the critical amount of oxygen for the fish, which, if prolonged, would result in mortality.

pH-ul. The pH value is a measure of the concentration of water in hydrogen ions. Knowing the pH value is also of great importance to a fish farmer, because:

1. Too much or too little is deadly for fish;
2. A constant value between 6.5 and 8 is favorable for reproduction.

The pH of the water in the pond depends first on the nature of the local geological substrate, but it can be modified by other factors, among which we point out the content in $CO_2$of the water. During the day, phytoplankton and higher vegetation consume $CO_2$from waterin photosynthetic activity and causes an increase in pH. The reverse operation takes place during the night, which leads to variations in this index. In slightly alkaline waters (low in carbonate and bicarbonate ions), the values range from 6-10. In alkaline waters the variations are small, between 7.5-8 and 9-10. PH values of 4 and 11 correspond to fish mortality thresholds. When values are between 4-6 and 9-10, fish growth is low and production is low.

In the rainy spring and autumn seasons, due to heavy rains, the pH decreases due to the large amounts of CO2 that dissolve in the water, reaching the value of 5.5-6. And in summer, as a result of torrential rains with electric discharges, the pH decreases, so the analysis samples should not be taken immediately after the rain.

During the summer the pH is high, sometimes reaching 9, due to the intensification of the photosynthesis process, through which the plants consume all the free CO2 from the water and then the bound in soluble bicarbonates, giving rise to calcium hydroxide, Ca (OH) 2 which has a completely alkaline reaction.

Under conditions of large amounts of dead organic matter, stored on oxygen-deficient bottoms, there is an increase in the concentration of CO2 (often H2 S) which leads to lower pH. If the waters are well buffered, ie they have a reserve of bicarbonates and phosphates, the pH will decrease slowly, to a lesser extent. If in the case of well-buffered waters with a reserve of 100 mg CaO / liter there are sudden drops in pH, this may indicate an extreme situation of pollution with organic matter.

Salinity. Water salinity, ie the total concentration of dissolved ions, is an important parameter because it conditions the phenomenon of osmosis in fish. It is of particular importance in the case of the brackish environment. Fish are very sensitive to sudden variations in salinity, especially larvae and juveniles, but they undergo gradual changes: thus,**H. molitrix** admits 8 mg/l, **Ct. idella** 12,00 mg/l, and**carp**until 9 g/l salinity.[6]

RESULTS AND DISCUSSIONS

It is very soluble in water (Table 12). Clean water at $25^{o}C$ requires a CO2 content of 0.48 mg / l.

Carbon dioxide is slightly toxic to fish. Most species survive for several days in water containing more than 60 mg / l, provided that oxygen is abundant (Hart, 1944, quoted by Boyd, 1982). Unfortunately, carbon dioxide concentrations are normal or high when the concentration of dissolved oxygen is low (Boyd, 1982). This results from the fact that carbon dioxide is the product of respiration and is used in photosynthesis. When oxygen is low, the process of photosynthesis is not fast. Usually, high concentrations of carbon dioxide occur in ponds when mass mortality of phytoplankton occurs after the difficulties of thermal stratification during periods of water turbidity. The relationship between carbon dioxide, bicarbonate and carbon and pH is shown in Fig.1.

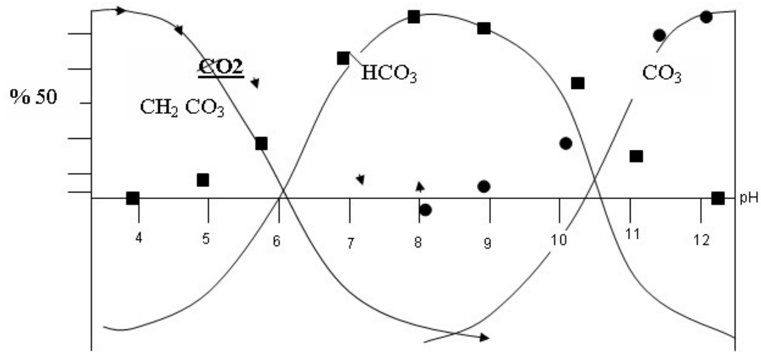

***Fig. 1.* Percentage relationship between fractions of CO_2, HCO CO and pH**

Alkalinity. The total alkalinity (ml HCl / l) is due to the free bases, carbonates and bicarbonates and is determined by their titration with 0.1n HCl. The optimal values for a fish water are 2 -4 ml HCl / l. The most productive waters are the slightly alkaline ones, in which the pH remains almost constant around the values of 7.4-7.6, with small variations around these values. If the pH changes are sudden, a chemical and physiological imbalance can occur which stresses the fish and can lead to their death.

If the fish waters have an assured alkaline reserve (alkalinities from 0.2 - 6 ml HCl / l) they can resist the acidification tendencies due either to the CO2 appeared during the night in the breathing processes, or due to the rains, especially those accompanied by discharges. when the amount of nitrites increases, which increases the acidity, either in the case of biogenic decalcification that leads to very large variations in pH, from 5.5 during the night to 12 during the day.

Fish have adapted to life in alkaline waters, so they develop with difficulty and get sick in acidic waters, especially juveniles can hardly withstand large amounts of free CO2 and the acidity given by the carbonic acid formed according to the reaction.[10]

CO2 + H2O → H_2CO_3

Total hardnessrefers to the concentration of bivalent metal ions in water, expressed in milligrams per liter in carbonate equivalent. Total density is usually related to total alkalinity, because of the ions alkalinity and hardness cations derive from mineral and carbonate solutions. Boyd (1982) demonstrates (Table 4) a high positive correlation between total alkalinity and total hardness in pond water. Total water density was graded (Boyd, 1982): soft, 0-75 mg / l; moderate to severe, 75-150 mg / l; strong, 150-300 and very strong, over 300 mg / l. From a fish point of view, a suitable hard water (8-120G) is very productive (1 degree = 10 mg CaCO3).

Waters rich in bicarbonates and appropriately supplied with carbonates and free CO2 are considered well-buffered waters, which can neutralize pH variations.[9]

When the total alkalinity of the water exceeds the total density, some of the bicarbonates are associated with sodium and potassium rather than calcium and magnesium and vice versa when the total density is higher. Fortunately, in most waters, total alkalinity and total hardness have similar concentrations. The water in the fish ponds must contain a small amount of calcium and magnesium, satisfactory when the density value is higher than 20 mg / l.

Nitrites (NO_2^-mg/l), the permissible concentrations in fish waters are below the value of 0.2 mg / l. The presence of nitrogen in fish waters is undesirable, as they show an advanced stage of decomposition of organic substances, in the absence of oxygen. Nitrogen is present in oxygen-deficient waters, charged with organic matter, where denitrifying batteries develop, capable of removing nitrogen from its compounds, passing it through the form of ammonia, and then releasing it in gaseous form.

Through this denitrification process, an important part of nitrogen is removed from the nutrient circuit, being passed from useful matter to toxic matter. ($NH_3$is toxic) or is taken out of the water (N_2comes out of the water).[7]

Nitrates are unstable substances, they are transformed in conditions of lack of oxygen into ammonia, but in conditions of good aeration of water, as happens in spring and autumn, they are oxidized immediately and converted into nitrates. Conditions for the appearance of nitrogen and ammonia appear either in summer, at high temperatures or in winter, due to the ice bridge formed, in both cases the oxygen being deficient. Ammonia is toxic if it is found in amounts greater than 2 mg / l, it causes asphyxiation of fish and their mass mortality.

Nitrates (NO_3^-mg/l), the optimal values for fish waters are in the range of 2.5 - 3 mg / l. Nitrates are the assimilable forms of nitrogen together with soluble phosphates, potassium salts are the mineral elements of prime importance in plant photosynthesis, which is why they are called "biogenic elements".

In fish waters, the origin of nitrates is either from mineral sources or from organic sources:

- Mineral sources are represented on the one hand by atmospheric nitrogen, which is transformed into nitrates by nitrogen-fixing bacteria, Azotobacter sp., Which are found in the mud at the bottom of the water. On the other hand, torrential rains accompanied by electric discharges supply waters with significant amounts of nitrites (NO2-), which in the aquatic environment are then oxidized and pass into nitrates (NO3-).
- The organic sources are represented by dead organisms, plants and animals, fallen on the bottom of the waters, which are subjected to the mineralization process. On well-oxygenated bottoms, nitrifying bacteria come into action, which transform the organically bound nitrogen, passing it through several steps to the nitrates.

Plants assimilate nitrates very well, which are easily soluble in water, they pass from plants to animals in the trophic circuit, so that they finally return to the water again in the form of protein nitrogen in dead organisms and in the form of ammonia in excrement.Due to the high solubility of nitrates, they cannot be converted into sparingly soluble compounds and therefore cannot accumulate on the bottom of basins, as is the case with phosphates. [8]

CONCLUSIONS

Organic matter CCO-Mn (mg KMnO4 / l) or the amount of oxidizable organic substances in water. For fish waters the optimal values for the organic substance are 35 - 50 mg KmnO4 / l, the values exceeding 80 mg KmnO4 / l are considered dangerous.

The ways of consumption and transformation of the organic substance in the water and on the bottom of the ponds are the following:

- Consumption of organic matter in the process of feeding aquatic fauna. It was found that first the bacteria benefit from it, then the filters from the groups of rotifers, bivalves, cladoceres, copepods, etc. Even in fish, the direct use of dissolved organic matter through osmosis processes has been highlighted.
- Decomposition of organic matter under aerobic conditions. In well-aerated waters, both organic substances in the water mass and those that fall to the bottom are subjected to a mineralization process, favorable to aquaculture, through which dead organic substances, under the action of oxidizing microorganisms, are transformed into mineral substances, the only form easily assimilated by plants. In the mineralization processes the role of oxygen is overwhelming.
- Decomposition of organic matter under anaerobic conditions. In poorly aerated waters, the organic substances on the bottom of the ponds are subjected to a process of putrefaction, unfavorable to aquaculture, through which dead organic substances, under the action of reducing microorganisms, are transformed into nitrogen and sulfur products poor in oxygen, almost all of which are toxic: amines, hydrogen sulfide, ammonia, etc. If the amount of dissolved oxygen in the water isless than 4 mg / l, the organic matter undergoes a process of putrefaction.

During the summer, in waters loaded with organic substances, due to temperatures that remain high for a long time, oxygen gradually decreases, the concentration of acids increases, the pH of the water decreases, thus producing a complete imbalance, chemical, biological and physiological, which leads to mass mortality of all aquatic organisms. If these decreases in oxygen are sudden, the danger is even greater for the fish, not having the time to retreat to better ventilated places. In these cases it is recommended either an aeration and a refreshment of the water, or a treatment with lime, or fishing, vacuuming and leaving the pond at rest for a summer and a winter to mineralize the organic matter on the bottom in the presence of air, sun, wind, frost.

ACKNOWLEDGEMENT

This work was supported by the Romanian Research and Innovation Ministry, through NUCLEU Programme, Project "PN 19 10 02 03: "RESEARCH ON THE INTENSIVE GROWTH OF FISH IN THE POLYCULTURE SYSTEM AND THE COMPLEX VALORIFICATION OF THE BIORESOURCES (PLANTS) OF AQUATIC", contract no. 5N / 07.02.2019 and ADER 25.3.1 „RECIRCULATING AQUACULTURE SYSTEMS USED IN THE PRE-MARKING STAGE OF NATURAL WATER REPOPULATION WITH FISHING MATERIAL", contract no **ADER 25.3.1 / 26.09.2019.**

BIBLIOGRAPHY

1.Agbaire, P.O, Akporido, S.O and Emoyan, O.O (2015). *Determination of some physiochemical parameters of water from artificial concrete fish ponds in Abraka and its environs*, Delta State,Nigeria.*InternationalJournal of Plant,* Animal and Environmental Sciences, 5(3): 70-76.

2.Akpotayire, S. I., Miikue -Yobe T.F.B., Kalagbor, I.A., Okpabi, D.A., Nwoha, N. and Needom, I. (2018). *Assessment of the physicochemical characteristics of artificial fish pond water in Ogoni: A case study ofKa-Gwara community*. Academia Journal of Scientific Research. 6(6):216-221.

3. Aladesanmi,O.T., Isaac F. Adeniyi , Ibukun M. Adesiyan (2014). *Comparative Assessment and Source Identification of Heavy Metals in Selected Fishpond Water, Sediment and FishTissues/Organs in Osun State, Nigeria.*Journal of Health and Pollution.4 (7):42-53.

4. Aydin, U. A. (2018), *Statistical assessment of water quality parameters for pollution source identification in Bektaş Pond (Sinop, Turkey)*, Global NEST Journal,20(1):151 160.

5. Danba E. P., David D. L., Wahedi J. A., Buba U. N., Usman D., Bingari M. S. and Tukur K. U.(2015). *Physicochemical analysis and fish pond conservation in Kano State*, Nigeria. *Archives of Applied Science Research*. 7 (6):28-34.

6.Dinesh, K. G., Karthik, M. and Rajakumar, R. (2017). *Study of seasonal water quality assessment and fish pond conservation in Thanjavur, Tamil Nadu, India*. Journal of Entomology and Zoology Studies: 5(4): 1232-1238.

7. Jeyaraj, M., Nirmaladevi, G and Magudeswaran, P. N (2014). *Assessment of Water Quality Index of Sulur Pond, Coimbatore-Tamilnadu, India*. International Journal of Emerging Trends in Science and Technology.1(7):1200 - 1204.

8.Kefas, M., Abubakar, K. A. and Ali, J. (2015). *The Assessment of Water Quality via Physicochemical Parameters and Macro*

Invertebrates in Lake Geriyo, Yola, Adamawa State, Nigeria. The International Journal of Science and Technoledge. 3(3):284-290.
9.Keremah, R. I., Davies, O.A. and Abezi, I.D (2014). *Physico-Chemical Analysis of Fish Pond Water in Freshwater Areas of Bayelsa State, Nigeria.*Greener Journal of Biological Sciences. 4 (2):033-038.
10. Orobator, P. O. and Asikhia M.O. (2013). UrbanAgriculture in Benin City, Nigeria. *Knowledge Review.* 28(1):20– 28.