OPEN ACCESS Freely available online

Fisheries and Aquaculture Journal

ISSN: 2150-3508

Research Article

Assessment of Water Quality Parameters for Aquaculture Uses: The Case of Guder River Main Tributaries of Nile, Ethiopia

Shambel Boki Dabi*

Department of Animal Science, Ambo University, Ambo, Ethiopia

ABSTRACT

This study aimed to asses' water quality parameters of Guder River for aquaculture uses. In this study the part of this river was demarcated into three streams (upper, middle and down). Five sites were selected from each stream. The water sample was collected at the depth of 10-15 cm in dry and rainy seasons into plastic bottles from each site of three streams for laboratorial analysis. The water sample was immediately analyzed by using titration method for water quality parameters like CO_2, Chloride and alkalinity while water turbidity, temperature, water pH and dissolved oxygen were taken onsite by direct measurements. Nitrite and ammonia were determined by using easy test kit. The result showed that alkalinity was high (66.3 ± 39.1 $mg.L^{-1}$) at downstream and lowest (58 ± 40 $mg.L^{-1}$) at middle stream. Concentration of CO_2 is high (14 ± 3.6 $mg.L^{-1}$ L) at the upper. The highest (28.7 ± 2.6 $mg.L^{-1}$) concentration of chloride was measured at downstream. pH value was ranged between 5.89-7.33 and the water temperature 23.4°C-26.2°C .The concentration of nitrite and ammonia were 0.01-0.04 $mg.L^{-1}$ and 0.03-0.05 $mg.L^{-1}$ respectively. The result showed that concentration of free carbon dioxide was significantly ($P<0.05$) influenced by site but there was no significant difference in the values of alkalinity and chloride in all the streams ($P>0.05$). Generally, even though concentration of studied parameter varies within different streams along the river basins they are within the range of fish production.

Keywords: Aquaculture; Dissolved oxygen; Turbidity; Water quality

INTRODUCTION

Aquaculture is a net consumer of water and most form require the use of considerable quantities and quality [1,2]. The different forms of aquaculture are quite similar because they all obey the same set of physical and chemical principles [3]. Surface water pollution is the major problem worldwide, caused by natural processes and anthropogenic activities [4]. The most serious threat to profitable fish production is poor water quality and lack of our acceptable quantity of water. The discharge of industrial effluents, raw sewage wastes and other waste pollute most of the environments and affect survival and physiological activities of aquaculture organisms [5,6]. Maintenance of good water quality is essential for both survival and optimum growth of aquaculture organisms. There are two main categories of water supply for aquaculture, ground water and surface water. However, not all available water is good enough for fish farming. The quality of water in terms of physic-chemical and biological characteristics in the fish ponds offers the most favorable conditions for the existence of fish as well as other biota which constitute essential components of the food chain [7]. Quality of the water in the production systems can affect the organism's health and the costs associated with getting a product to the market. Water quality parameters that are commonly monitored in the aquaculture industry include temperature, dissolved oxygen, pH, alkalinity, hardness, ammonia, and nitrites [8]. Depending on the culture system, carbon dioxide, chlorides, and salinity may also be monitored. There is much variation among fish groups with regard to acceptable water quality requirements have been variously defined [9], to ensure optimum production. According to Nikolosky fishes are most dependent on water temperature, pH, dissolved oxygen, free carbon dioxide, alkalinity, chlorine, and some other salts for growth and development. If one of these parameters changed, they may

Correspondence to: Dr. Shambel Boki Dabi, Department of Animal Science, Ambo University, Ambo, Ethiopia, E-mail: dshambelboki@yahoo.com

Received: 05-Jan-2022; Manuscript No. FAJ-22-45505; **Editor assigned:** 07-Jan-2022; PreQC No. FAJ-22-45505(PQ); **Reviewed:** 21-Jan-2022; QC No. FAJ-22-45505; **Revised:** 26-Jan-2022, Manuscript No. FAJ-22-45505(R); **Published:** 02-Feb-2022; DOI: 10.35248/ 2150-3508.22.289

Citation: Dabi SB (2022) Assessment of Water Quality Parameters for Aquaculture Uses: The Case of Guder River Main Tributaries of Nile, Ethiopia. Fish Aqua J.13:289.

affect the growth, development and maturity of fish [10]. This means each water quality parameter alone can directly affect the animals´ health.

Guder is a river of central Ethiopia. It is a tributary of the Blue Nile on the left side and tributaries of the Guder include the Dabissa and the Taranta. The Guder River has a drainage area about 7,011square kilometers in size. Therefore, it is important to check the quality of water and make sure it can sustain the fish. Hence, this paper aims at assessing the present water quality of Guder River for aquaculture uses which is one of tributaries of Blue Nile in relation to aquaculture uses. The majority of water resource that we have in this country is unstudied in relation to aquaculture production. In addition to this, Ethiopia has no strong guideline on the limit of toxic substance like ammonia and heavy metals release from agricultural farm and industries to rivers that can affect the health of aquatic animals. The pesticide, fungicide, herbicide and fertilizer that farmers used to increase their production are also the source of pollutant for aquatic organism by changing the equilibrium of water quality parameter.

MATERIALS AND METHODS

Sample size and sampling techniques

The present study was carried out for a period of one year starting from December 2018 to August 2019. Guder River was selected in this study and the river basin of this river was demarcated into three streams. The river basins above town was alienated as upper stream (southern part), within town as middle stream (area of the river within Guder town) and bellow town as downstream (Northern part) based on pollution load. The water was sampled between 9:00-12:00 AM in six months both in dry seasons (December, January and February) and rainy seasons (June, July and August). Ninety (90) water samples were collected usually in both seasons from 10-15 cm depth from five sites at the interval of 0.8 km per streams into transparent plastic bottles of one liter capacity for laboratorial analysis. The sites within the streams were selected based on location, natural and man-made pollution source. The sampled water was immediately analyzed by using titration method for water quality parameters like CO_2, Chloride and alkalinity in ambo university department of animal science laboratories while water turbidity, temperature, water pH and dissolved oxygen were taken onsite by direct measurements. Nitrogen compound concentration of ammonia and nitrite were determined by using interpret easy ammonia test kit and nitrite test kit respectively.

Determination of water quality analysis: Total alkalinity in $mg.L^{-1}$ =T × N × 50 × 1000/S

Free carbon dioxide in mg/L=T × N × 22 × 1000/S and Chlorides in $mg.L^{-1}$ =T × N × 35.5 × 1000/S

Ammonia and nitrite: Using interprets easy ammonia/nitrite test kit respectively.

Onsite measurements for physical parameters: Dissolved oxygen (Hand held dissolved oxygen meter), Water pH (pH meter), Turbidity (Portable turbidity meter (BANTE TB100), Temperature (Laboratory thermometer)

Data analysis

The data was presented by using descriptive statics such as mean, standard error of means and p value. For statistical data analyses, one way analyses of variance was applied to test the significance difference among different values. All analyses were performed using software program Statistical Packages for Social Science (SPSS version 20) P = 0.05 was used (Figure 1).

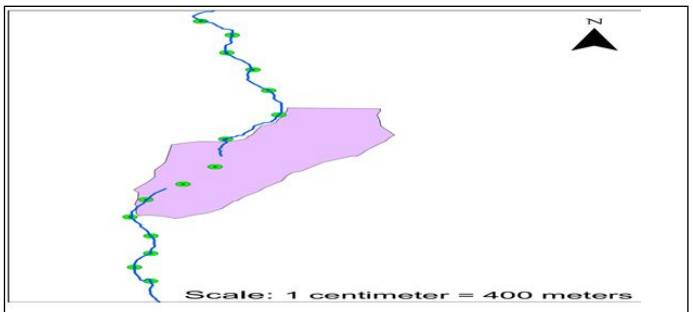


Figure 1: Map of Guder River indicates where sampling sites located. A: (—) Guder town; B: (—) Guder River; C: (—) Sampling line.

RESULTS

Concentration of alkalinity varies among the three streams during dry seasons Figure 2A. During rainy seasons high concentration of alkalinity was observed at down streams while low concentration of alkalinity was observed at middle streams (Figure 2A). There was no significance difference due to site/ stream difference along the river basins (Figure 2B).

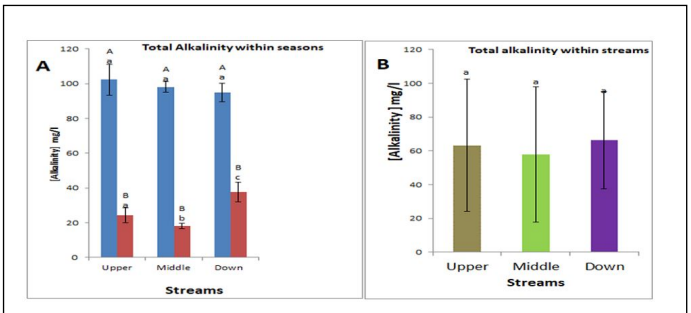


Figure 2: Concentration of alkalinity in the Guder river basins in dry and rainy seasons (— Dry season; — Rainy season). A: Concentration of alkalinity along Guder river basins in the whole year round. B: Values are (means ± S.E, n=5).

There was significant difference of chlorides concentration at the upper streams between rainy and dry seasons (Figure 3A). However, there were no significance differences on the concentration of chlorides concentration along the river basins throughout the year (Figure 3B).

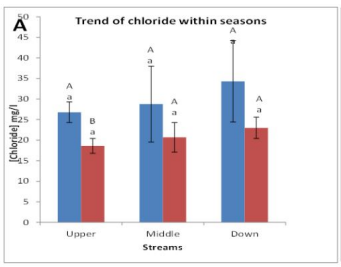
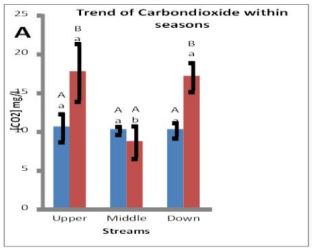


Figure 3: Concentration of chlorides in the Guder river basins in dry and rainy seasons (— Dry season; — Rainy season). A: Concerntration of chlorides along Guder river basins in the whole year round. B: Values are (means ± S.E, n=5).

Highest concentration of carbon dioxide observed at the upper stream of Guder river basins while the lowest concentration seen at the middle of the streams. There were no significant differences observed on the concentration of carbon dioxide in dry season (Figure 4A). There were high significance differences observed at middle stream when compare with upper and down among streams (Figure 4A). Overall, high concentration of carbon dioxide was observed at the upper stream and the lowest concentration of carbon dioxide was seen at the middle part of the stream. Concentration at the middle stream was significant different from the upper and downstream (Figure 4B).



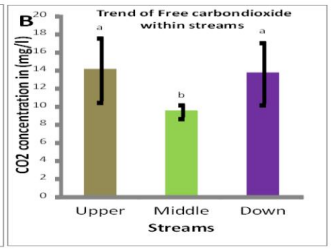


Figure 4: Concentration of carbon dioxide in the Guder river basins in dry and rainy seasons (—Dry season; — Rainy season). A: Concentration of carbon dioxide along Guder river basins in the whole year round. B: Values are (means ± S.E, n=5).

The value of water pH was increased from the upper streams to downstream. Concentration of DO was maximum at the middle stream, while concentration of carbon dioxide inversely proportional to concentration of DO in each stream. This result showed that when the value of water pH increased the concentration of carbon dioxide in the water decreased (Figure 5 and Table 1).

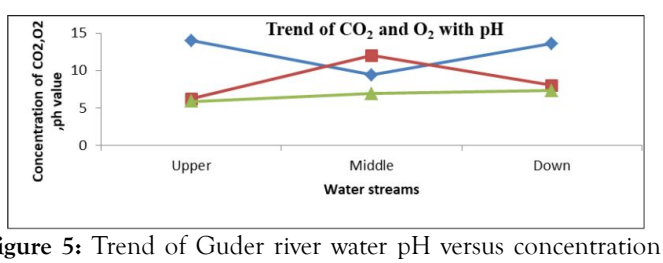


Figure 5: Trend of Guder river water pH versus concentration of D.O and CO_2. A: — CO_2; B: — DO; C: — Ph.

Stream	Upper	Middle	Down	Average
Concentration of water quality parameters in both seasons				
Alkalinity ($mg.L^{-1}$)	63.3	58	66.3	62.53
DO ($mg.L^{-1}$)	6.2	12	8	8.73
CO_2 ($mg.L^{-1}$)	14	9.4	13.6	12.33
Chlorides ($mg.L^{-1}$)	22.7	24.4	28.4	25.16
Ammonia ($mg.L^{-1}$)	0.05	0.01	0.03	0.03
Nitrite ($mg.L^{-1}$)	0.04	0.02	0.01	0.02
Temperature (Celsius)	24.6	23.4	26.2	24.73
pH	5.89	6.9	7.33	6.71
Turbidity (NTU)	178	250	317	248.33

Table 1: Overview of measured water quality parameters in the study area.

DISCUSSION

Alkalinity

The quantity of base present in water defines what is known as total alkalinity. In this study the concentration of alkalinity in different site is different. Concentration of alkalinity is high at all streams during dry seasons. This may be due to the fact that during dry seasons there is discharge of waste materials from the house hold and institutions as it cannot dilute as in the rainy seasons. However, concentration of alkalinity is varying among the three streams during dry seasons (Figure 2A). This shows at the upper stream there was less discharge of waste materials to the river in dry seasons and at the middle stream there was continuous flow of waste materials to the rivers both in rainy and dry seasons. The average mean of alkalinity from upper to downstream ranges from 58-66.7 $mg.L^{-1}$ .This study indicated that the concentration of alkalinity is varies not because of different site along the river (Figure 2B) but because of seasonal variation especially during dry seasons when the volume of water bank is reduced to minimum level between December to January.

Chlorides

Chloride is a component of most waters and is essential in helping fish maintain their osmotic balance [11]. There is no significance difference during rainy and dry seasons along the river basins in all streams (Figure 3). This may indicate there are no auxiliary sources of chlorine sources that can be added from the surroundings. Most of the time chloride is added to the

water in order to control bacteria. There are no as such municipal wastes from the Guder town and agricultural activities by surrounding farmers. Chloride levels higher than 70 $mg.L^{-1}$ are a concern if the water is also used to irrigate sensitive land-based crops as in our study the maximum level of chloride is 35 $mg.L^{-1}$ which is normal for fish production.

Free carbon dioxide

In addition to respiration in aquatic animal decomposition of organic matter is also a major source of free CO_2 in fish ponds [12]. In the present study there were high significance differences observed at middle stream when compare with upper and down among streams (Figure 4B). This is due to the fact that at the middle stream there is high chance of nutrient accumulation which case growth of aquatic plants. This high growth of aquatic plants does photosynthesis which cause low concentration of CO_2 in the water. On the other hand high concentration of CO_2 observed at upper and downstream is due to less chance of nutrient accumulation in the water led less aquatic plant availability, less photosynthesis. This finding related with the report [13], whose report as most fish are able to tolerate 20 $mg.L^{-1}$ CO_2 without bad effect. For example, catfish can tolerate 20-30 $mg.L^{-1}$ CO_2. Concentration of carbon dioxide was more varies among the streams during rainy seasons (June to July) (Figure 4A.). This may be due to the intensity of sun light during rainy season or the turbidity of water because of agricultural runoff water loaded with suspended solid which hinder the reaction of CO_2 with water to produce glucose and oxygen for life.

Dissolved Oxygen (DO)

Water of Guder River is well oxygenated during different time intervals and along the three streams. Upper stream had the lowest average value (Table 1). During the year as a result of decomposition of organic matter and detritus materials consumed the dissolved oxygen. The maximum value of DO (12 $mg.L^{-1}$) w as recorded at middle stream due to decreasing of temperature and to the prevailing winds which permit to increase the solubility of atmospheric oxygen [11-13].

Nitrite

In the present study the concentration of nitrite at upper stream exceeds much more than other parts in the river which mainly attributed to different agricultural activities in the area. Nitrite showed its minimum value (0.01 $mg.L^{-1}$) at downstream, while the maximum value (0.04 $mg.L^{-1}$) was recorded at upper stream. It is clear that, the increase of nitrite concentration attributed to the oxidation of ammonia yielding nitrite especially in abundant of dissolved oxygen. According to OATA 2008 the recommended concentration of nitrite should not exceed 0.2 $mg.L^{-1}$ in freshwater and 0.125 $mg.L^{-1}$ in seawater.

Ammonia

In current study an abrupt increase of ammonia concentration seen at upper stream (Site 1 and 2) were due to the direct impact of agricultural activities inflow from different tributaries of Guder River. Thus, the rate of ammonification process increases converting the organic matter to ammonia especially at high temperature, therefore the maximum ammonia value (0.05 $mg.L^{-1}$) was recorded during rainy seasons. The downstream and middle stream parts of the river showed slight fluctuations. The maximum limit of ammonia concentration for aquatic organisms is 0.1 $mg.L^{-1}$. But there is disagreement on the maximum limit of ammonia level in the water. For example, according to Pillay in fish farming, the maximum save level of ammonia allowed is about 0.02 $mg.L^{-1}$ (at pH 7.0). Therefore, whatever the report of different authors this finding is within the range of previously reported boundaries of less than the maximum limit [10,12].

Temperature

The water of Guder River temperature fluctuates from site to site and with different seasons (23.4°C -26.2°C) (Table 1). According to Delince 30°C-35°C is tolerable to fish rearing. Temperature greater than 35°C is lethal to maximum number of fish species. Our finding closely agreed with previously reported [13], who reported as suitable water temperature for carp culture is between 24°C and 30°C. This implies that the water temperature of Guder River is above all recommendable for carp culture than other fish species.

Water pH

The pH values of Guder River were varied between 5.89-7.33(Table 1) with slight site and seasonal variations. The lowest pH values were mostly recorded in the upper part of the river due to high concentration of free carbon dioxide recorded as result of may be fermentation of the organic matter and liberation of hydrogen sulphide and methane gases which lead to lowering pH values. However, in the downstream of the river high pH value recorded (7.33) may be due to as previously suggested by other authors carbon dioxide, carbonate-bicarbonate equilibrium affected more due to change in physico-chemical condition [13].

Turbidity

Turbidity is the cloudiness of water. High turbidity of water can decrease fish productivity, as it will reduce light penetration into the depth of water and thus oxygen production by the aquatic plants. It can result from suspended solids or plankton. In our study minimum turbidity observed at the upper stream (178 NTU) (Table 1) is may be due to at the upper stream there is less chance of water to be met with a lot of suspended solid. On other hand the maximum (317 NTU) turbidity was observed at downstream which might result from high content of waste materials released from Guder campus and Guder town.

Water pH versus free CO_2 and DO

Water quality in fish ponds is affected by the interactions of several chemical components like CO_2 and pH [10]. The value of water pH was increased from the upper streams to downstream. This indicates the middle and downstream there is high chance of waste water to be added from the Guder town to

the river which increase the organic matter in the water or increase the basic characteristics of the water. When pH exceeds above the levels that organism can tolerate, it may result in numerous negative effects on fish by reducing growth rate and even causing mortality [9]. Concentration of carbon dioxide is inversely proportional to concentration of DO in each stream (Figure 5). This inverse relationship of DO and CO_2 designates DO is available when there is sunlight for photosynthesis. During the day oxygen is produced as a result of photosynthesis, the process by which green plants convert water and carbon dioxide in the presence of light. During the night and day oxygen is consumed through respiration, the process by which plants and animals use oxygen to produce carbon dioxide as they burn carbohydrates. In current study the maximum concentration of DO at middle stream replies there is enough sunlight to do photosynthesis from CO_2 and water. In fact at the middle stream there is better nutrient accumulation which cases the growth of phytoplankton to produce high concentration of carbon dioxide. The values recorded for DO were still within the permissible range for aquatic survival, given than DO value below 5 $mg.L^{-1}$ impairs the growth and reproduction of fish, furthermore making them more susceptible to disease and becomes deleterious below 2 $mg.L^{-1}$ [6-9].

CONCLUSION

This study has provided information about water quality status of Guder River and its suitability for aquaculture uses. The water quality varies considerably between sources at different sites due to imbalance of the water ecosystem that disturbed by agricultural activities and release of waste water from Guder town to the river. This study prove that at the site where there were high concentration of carbon dioxide we found less concentration of dissolved oxygen and at high pH value there is high accumulation of ammonia concentration was seen. This study found that water turbidity was high during rainy seasons as the result of anthropogenic activities (agricultural activities like pesticide, herbicide and fertilizer) and discharge of wastes from Guder town. However, the concentration of carbon dioxide, alkalinity, dissolved oxygen, temperature, turbidity, nitrite, ammonia, and chloride and water pH from Guder River is an indicative to culture most of freshwater fishes like. Cat fish *(Siluriformes)* , Common carp *(Cyprinus carpio)* , Perch (*Perca*), Salmon (*Salmo salar*), Trout (*Oncorhynchus mykiss*) and Tilapia (*Oreochromis niloticus*). In general, this study confirms that Guder River is suitable for fresh water fish production.

REFERENCES

1. Bhatnagar A, Devi P. Water quality guidelines for the management of pond fish culture. Int J Environ Sci. 2013;3(6):1980-2009.
2. Bhatnagar A, Singh G. Culture fisheries in village ponds: a multi-location study in Haryana, India. ABJNA. 2010;1(5):961-8.
3. Boyd CE, Gross A. Water use and conservation for inland aquaculture ponds. Fish Manag Ecol. 2000;7(1-2):55-63.
4. Dabi SB. Effect and necessity of anthropogenic copper on fresh water aquaculture organisms: A review. J Fish Res. 2020;4(1):36-40.
5. Cao L, Wang W, Yang Y, Yang C, Yuan Z, Xiong S. Environmental impact of aquaculture and countermeasures to aquaculture pollution in China. Environ Sci Pollut Res. 2007;14(7):452-62.
6. Sandeep P, Ramudu KR. Effect of water quality parameters on growth and survivability of mud crab (Scylla Tranqubarica) in grow out culture at Kakinada coast Andhra Pradesh. Indian J Agric Res. 2016;34(1):127-30.
7. Stone NM, Shelton JL, Haggard BE, Thomforde HK. Interpretation of water analysis reports for fish culture. Mississippi: Southern Regional Aquaculture Center; 2013.
8. Taege N. Water surface and show symptoms of suffocation even though the concentration of oxygen in water. 1982.
9. Schröder P, Navarro-Aviñó J, Azaizeh H, Goldhirsh AG, DiGregorio S, Komives T, et al. Using phytoremediation technologies to upgrade waste water treatment in Europe. Env Sci Pollut Res. 2007;14(7):490-7.
10. Schröder P, Juuti S, Roy S, Sandermann H, Sutinen S. Exposure to chlorinated acetic acids: Responses of peroxidase and glutathione S-transferase activity in pine needles. Env Sci Pollut Res. 1997;4(3): 163-71.
11. Chaudhry Q, Schröder P, Werck-Reichhart D, Grajek W, Marecik R. Prospects and limitations of phytoremediation for the removal of persistent pesticides in the environment. Env Sci Pollut Res. 2002;9(1):4-17.
12. Cape N, Forczek S, Gullner G, Mena-Benitez G, Schröder P, Matucha M. Progress in understanding the sources, deposition and above-ground fate of trichloroacetic acid (11 pp). Env Sci Pollut Res. 2006;13(4):276-86.
13. Mohammed M, Markert B. Toxicity of heavy metals on scenedesmus quadricauda (Turp.) de brébisson in batch cultures. 2006;13(2):98-104.