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Diversity of Fishes with relation to some physic-chemical parameters in Kindo-Koysh of Wolaita Zone, around Gibe III Reservoir, Southern Ethiopia

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Abstract

Ethiopia is a country with an area of water bodies covering approximately 7400 $km^{2,}$ home of diverse aquatic life including more than 180 fish species of which about 40 are endemic. The diversity in some of the lakes and rivers is exceptionally well than others. The present study is made on the river basin of Omo along side of the Gibe III Hydroelectric reservoir between November, 2022 to May, 2023 at three different sites.

To study the diversity of fishes along with selected physic-chemical parameters sampling of water, collection of fishes and laboratory analysis of sampled water was done. The average value of pH was 7.78 with the lowest and highest values of 7.35 and 8.1 at sampling sites. The water temperature ranged between 31.9 - 30.9°C with an average value of 31.2°C. The temperature variations in the lake were normal for metabolic activities of organisms such as fish production. Mean DO of the reservoir was 6.34 mg.lit-1 with lowest and highest values of 5.4 – 6.98 at sampling stations which is at the normal range. The conductivity was found from three water samples between (84.5- 57.9) µS.cm-1 with an average value of 69.63 µS.cm-1. Using electrical conductivity as water quality index (Moore, 1989), the lake has good water quality of its range 80.40–178.80 µS.cm-1. TDS show total dissolved solids resulted from dissolved salt and rock particles in the water it is positively correlated with conductivity.

During the present study a total of 38 specimens belonging to 8 families were identified from all three sites out of which nine were frequently distributed and studied thoroughly. Some of the species such as Mermoids, Cichlidians found were very rare and endemic in nature. Based on the study report it can be concluded that the ecology and water quality of the reservoir is suitable for Aquaculture and possibilities for commercial exploration for fish production.

Keywords

Aquaculture, Endemic, Fisheries, Gibe III reservoir, Omo river, Physico-chemical

Introduction

The aquatic products such as aquaculture and fisheries sector remains an important source of food security, nutrition, income, poverty alleviation and livelihood for hundreds of millions of people around the world (FAO, 2016). Hence, the fishery sector is considered as one of the potential intervention areas by the Ethiopian Ministry of Agriculture to provide employment and alternative source of income in rural areas. Studies reported that the fisheries sector alone employs 12.3 million people, representing 2.1 percent of Africa's population. At the country level, Nigeria stands as foremost with almost 2 million people engaged in the fisheries and aquaculture sector, followed by Morocco (almost1.4million) and Uganda (almost1million) (FAO, 2014).

In addition to providing employment and food security, fisheries play an important role in local and national economies in numerous ways: by contributing to food supplies and nutrition, helping stimulate the growth of a cash-based economy through the sales by small scale fish-based enterprises, generating government income through fees and taxes and creating foreign exchange earnings through exports and international fishing agreements (FAO, 2006). The majority of the people employed by the sector are small-scale fishers and fish workers and their activities are particularly important to poverty alleviation. Mostly the industry use small vessels and often fish inshore for local and domestic markets although export-oriented production has increased significantly during the last couple of decades (FAO, 2008). Despite many development efforts, constant poverty still remains a nasty reality for millions of Africans.

Ethiopia is an agrarian country where agriculture is the dominating sector, contributing about 43% of GDP, 85% of employment and 90% of total export earnings, as well as providing 70% of raw materials for the industrial sector (Demese et al., 2010, Tesfaye and Wolff, 2014). However, the country has been facing food insecurity and malnutrition for long time despite its great potential for expanding agricultural production and productivity. Ethiopia is a country with an area of 1,127,127 km^2, water bodies cover approximately 7400 km^2 (Cheffo, Teshome, &Tesfaye, 2015). In Ethiopia, water bodies are a home of diverse aquatic life including more than 180 fish species of which about 40 are endemic (Birhanu, 2015).

The aquatic resources provide alternative means of the most needed protein in several countries in the world. However, the aquatic resources of Ethiopia are underexplored and also underutilized. The average per capita consumption of fish in the world (consumption per person per year), at present, is 18 kg while it is, on the average, 8 kg in Africa while the per capita production (not consumption) in Ethiopia is only 260 grams, one of the lowest in the world. While the world is generating about US$ 187 Billion annually from the sector, Ethiopia is getting only about US$20 Million (Abebe, 2013). The overall potential yield of fish in Ethiopian water bodies is estimated to be 94,500 tons per year on average (Tesfaye and Wolff, 2014). Hence, the existing role of the fishery sector is immaterial in the country's overall economy since it is far below its potential. Similarly, the World Bank (2012) stressed that the contribution of the fishery sector is less than 1% of a country's Gross Domestic Product (GDP) though the sector has huge potential for the economic growth of the country. As discussed by Mwangi (2008), the fishery sector contributes significantly to the national economy through employment generation, poverty reduction and food security support.

The livestock and fisheries sectors have given priorities in the government's second Growth and Transformation Plan (GTPII) from 2016 to 2020 (World Bank, 2017). According to Lemma (2012), although there is some form of fisheries practiced in most freshwater bodies in Ethiopia, commercial fishery is concentrated at Lakes Tana, Chamo, Ziway, Abaya, Koka, Langano, Hawassa and Turkana. Similarly, Hirpo (2017) underscored that 40% and 50.2% of fish supply to the major urban centers in Ethiopia are captured from the Rift Valley lakes and Lake Tana. Indicating that rivers and hydroelectric dams and other water bodies with little infrastructure were underutilized and their roles food security and economic development is not mentioned.

This present study henceforth focuses on three adjacent villages located near the Gilgel Gibe III hydroelectric dam of Kindo Koysha districts of Wolayta Zone. Consequently, this study will be conducted to assess the diversity and level of fish production in the area and also to establish on record the quality of water by checking the physico-chemiacal parameters, to asses finally whether any potentiality of Aquaculture in the research area.

Omo-Gibe (Omo-Turkana) Basin

Omo-Gibe is one of the largest river catchments stretching over 150 kms in the Omo-Turkana Basin within the limits of Ethiopia. The principal stream of the basin namely Omo-Gibe River has its origin in the south western Ethiopian highlands at an elevation of about 2,200 m.s.l having outflow with 760 km long (CSA, 2009) traversing Oromia and Southern Nations Nationalities and Peoples (SNNP) regions of Ethiopia, ending up in Lake Turkana in the lowlands of 365m.s.l. The major tributaries, in the upstream to downstream order, include Gojeb, Gilgel-Gibe, Amara, Alanga, Denchiya, Mui, Zigina-Shoshuma,Mantsa,and Usno. Omo-Gibe Basin offers a mixture of fertile grasslands, forests, terraced hillsides and broad rivers, and is rich in wild life resources, with five national parks: Omo, Mago, Chebera-Churchura, Maze and Omo-Sheleko national parks. The riverine vegetation along the Omo-Gibe River can be described to be a combination of open canopy woodland, shrub thicket and grassland prevailing on and near the modern delta; closed canopy woodland and forest predominating in the meandering segment middle to upper basin (Carr, 1998).

Ichthyo faunal studies of Omo-Turkana Basin

Omo-Turkana Basin was perhaps first explored in the second half of 19th century during Dr. Donald Smith‘s Lake Turkana expedition between 1894 and 1895. Eight fish species, with one new description, were identified from Dr. D. Smith‘s Lake Turkana collection (Günther, 1896). In the early 20th century, 5 species were identified from Omo River collections of R. Neumann (1867–1946) & C. von Erlanger (1872–1904) (Boulenger, 1903a). Contemporarily, 14 fish species in the middle to upper Omo River and 5 species in the northeastern end of Lake Turkana were identified from the collections made by W. N. McMillan and P. C. Zaphiro (Boulenger, 1906). However, Golubtsov and Darkov (2008) later on increased the number of species list for the Omo-Turkana system to 76–79.

Materials and Methods

General Description of Study Area

The Gibe III dam is located within the Gibe- Omo River Basin, in the middle reach of the Omo river around 450 km by road south of Addis Ababa lying between 312,044E and 757,343N and 312,542E and 757,107N. The reservoir stretches over five zones, eleven Woredas (Districts) and 67 kebeles (villages). However, to make the study more amicable, the present study is restricted to three kebeles of Kindo Koysha namely Fajena Mata (site-I), Maneara (site-II) and Cherache of Wolaita administrative zone.

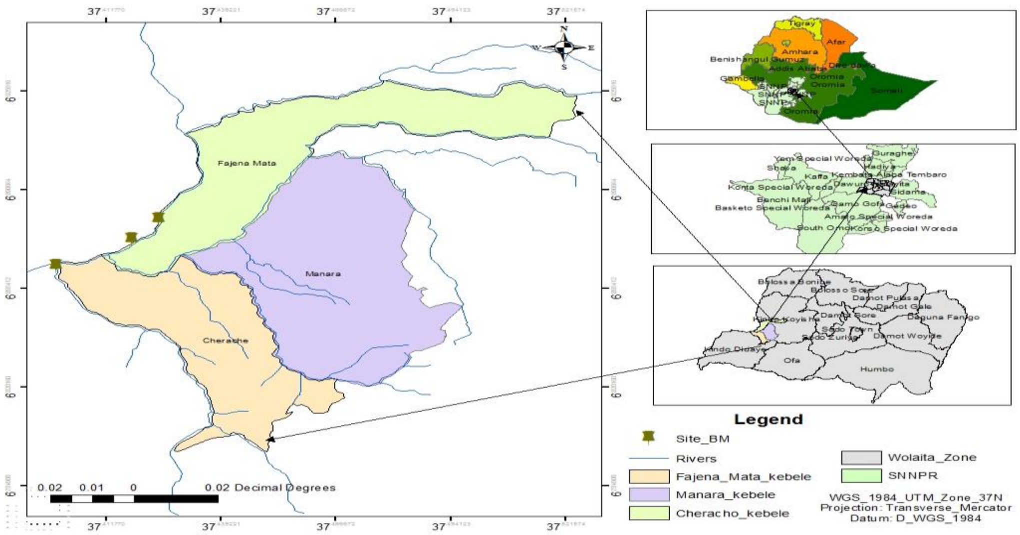

Figure 1: Map showing study area with Gibe III reservoir stretches

Sampling sites

The fish samples were collected from three villages of Kindo Koysh district of Wolaita zone. The first site called Fajana Mata (**site-I**) site is highly exposed for direct human interaction specially Dawro –Wolaita boat transport and cage farming by ASA Ethiopia. The remaining two sites Manera (**site-II**) and Chareche (**site-III**) were little far and surrounded by terraced hillsides mountains which was difficult for direct human encounter. All sites were predominated with sandy soil and rocky bottom because of Hillside Mountains.

Table 1: Geographic coordinates of Sampling sites and Sampling season

		Geographical location	
Sites	Altitude (meter)	Latitude N	Longitude E
Faj	866m	$6^0$54'18".18 N	3726'39".39 E
Man	866m	$6^0$53'36".84 N	3736'33".81 E
Cha	866m	$6^0$52'8".61 N	3725'10".60 E

Field materials

Motorized boats were used along with small wooden boats called Jelba were used fishing crafts while seine nets and gill nets were used as gears. The collection was made early morning between 7.00 am to 9.00 am. To study the physico- chemical parameters various field as well as lab based standard instruments were utilized. After the field observation the water samples and fishes were transported to the WSU lab for further investigation. The identification of fish was made using the standard key books along with the native authors e.g., "The fresh water fishes of Ethiopia Diversity and Utilization" Getahun (2017).

Fish sampling

Fish samples were collected during the study periods from all the three localities. Gillnets were mostly used for sampling. The gill nets had stretched mesh sizes of 8 cm, a panel length of 100 m and width of 1m per mesh size. Three sets of gillnets were fixed in all the three villages up to the shore, set at a subsurface level at each sampling site. Each site was sampled for dry and wet season. After the morphological study for identification, the fish specimens were fixed in 10% formalin. Morpho-metric, scale counting methods and specific observations were made for each collected fish.

Physico-chemical parameters of study site

Physico-chemical parameters were measured in situ in all sampling sites together with the fish sampling. Atmospheric temperature (Ta), Subsurface water temperature (Tw) , dissolved oxygen (DO), pH, Water conductivity (Cond), and total dissolved solids (TDS) were measured using portable multi-parameter meter of model 900P of BANTE instruments and respective instruments (Systronics) as well as procedures.

Results and Discussion

Physico-chemical parameters

The physical and chemical factors investigated in this research have been used to assess the water quality of some African reservoirs (Nhiwatiwa and Marshall, 2007; Mustapha, 2008).The physicochemical parameters obtained from analysis of water samples were presented in Table 2 below.

Table 2:Physico-chemical parameters of the sites

Parameter	Site-I	Site-II	Site-III	Average value
DO (mg/L)	5.4	6.65	6.98	6.34
Ta ^{0}C	33.8	32.4	32.4	32.86

Tw ^{0}C	31.9	30.9	30.9	31.23
Cond (µs/cm)	84.5	66.5	57.9	69.63
pH	8.1	7.9	7.35	7.78
TDS ppm	86.7	63.4	58.7	69.6

The average pH value was 7.78 with the lowest and highest values of 7.35 and 8.1 at sampling sites, most suitable for fish growth and production. The present results obtained for pH are similar to the results obtained by Adefemi*et al*. (2007); Adefemi and Awokunmi (2010). Values of pH below 4.8 and above 9.2 are deleterious for aquatic organisms specifically for fish. The water temperature ranged in between 31.9-30.9°C with an average value of 31.2°C. The temperature of water sample from Site-I site was higher than those obtained from Site-II and Site-III. This could be due to Rocky Mountains, less vegetation and over exploitation due to anthropogenic activities. Increase in the rate of chemical reaction and nature of biological activities could be added as further reasons for such growth.

Dissolved oxygen (DO) is essential for water quality, ecological status, productivity and health of a lake. This is due to its importance as a respiratory gas, and its use in biological and chemical reactions (Mustapha, 2008). Depending upon water temperature and salinity, saturation rate DO varied between 5- 9 mg.lit^{-1}. Oxygen demand for decomposition of materials results in depletion of DO in water and threatens aquatic life and water quality. Mean DO of the reservoir was 6.34 mg.lit-1 with lowest and highest values of 5.4 at at site-III and 6.98 at site-I sampling station which is at the normal range. Temperature is a measurement of the intensity of heat stored in a volume of water (RISC 1998).

High water temperatures increase the metabolic oxygen demand, which in conjunction with reduced oxygen solubility, impact many species (RISC 1998). Temperature strongly influences dissolved oxygen as oxygen solubility decreases with increasing water temperature. The amount of dissolved oxygen in a lake is also related to photosynthesis and respiration rates as well as mechanical actions such as wind. Photosynthesis releases oxygen in the day light hours and the consumption of oxygen during the night results in lower pre-dawn levels (Sharifinian*et al.*, 2013). The conductivity serves as a good and rapid measure of the total dissolved solids in water (Srivastava*et al*., 2011).

The conductivity was found from all the three water samples were between 84.5- 57.9 µS.cm^{-1} with an average value of 69.63 µS.cm^{-1}. Using electrical conductivity as water quality index (Moore, 1989), the reservoir contained good water quality of its range 80.40–178.80 µS.cm^{-1} will protect diverse species of organisms. TDS show total dissolved solids resulted from dissolved salt and rock particles in the water it is positively correlated with conductivity.

Fish species diversity

During the study a total of 38 specimens were collected from three sites belonging to 8 families were identified.

Family	Scientific name	Common name	Characters
Family Alestidae	***Brycinus macrolpiditus* (valenciennes, 1849)**	Big scale tetra; ‘’shimelo’’ in Amharic	1. Snout flatted above 2.Dorsal fin origin behind level of pelvic fin insertion 3. Number of outer premaxillary teeth 8-14 4. pper jaw projected beyond lower jaw 5. 22-23 scales in lateral line 6. Anal fin with three spines and 10-14 branched rays.
Family Mochokidae	***Synodontis frontosus* (Vaillant, 1895)** **Synonyms:** Synodontisciternii; synodontis frontosa		1. Dorsal spine (total)-1 2.Dorasal rays (total)- 7 3. Anal spine –zero 4. Gill slits not extending ventrally beyond pectoral fin insertion 5. Maxillaryberbel longer than head, unbranched, without tubercles and bordered by ashort but distinct darkbasal membrane 6. Denticulations of pectoral fin spines stronger on inner and hardly visible on outer margin 7. First branched ray of dorsal andpectoral fins prolonged into filaments 8. Adipose fin high and long, distinctly separated from rayed dorsal fin 9. humeral process deep, pointed ventiraly 10. Body covered with very small black specks; caudal fin without spots or dots
Family Schilbeidae	***Schilbe mystus* (Linnaeus, 1758)**	African butter cat fish	1.Scale absent, mouth terminal with four pairs of barbels 2. Compresed body and an adipose fin is always present 3. Grow upto 40cm 4. Brownish on the head and dorsal surface of fish and silver-white on the underside 5. Fins are usually colorless 6. Commonly found in standing or slowly flowing open water of ponds,lakes, rivers and shallow swamps 7. found in sand or rocky streams 8. Active during night
Family Mormyridea	***Mormyrus kannume* (Forsskal, 1775)**	Elephant fish, ‘AytoAssa’ in amharic	1.Dorsal spine zero; anal spine zero 2.Dorsal head profile straight or 3.somewhat curved, sloping steeply 4.Snout produced into stout trunch 5.Lip thick 6.Eye small 7.Dull bronze dorsally, lighter ventrally
Family Bagridae	***Bagrus bajad* (Forsskal, 1775)**	‘’Ambaza’’ in Amharic	1. Dorsal 9 rays 2.Maxillary barbell reaching extremities of ventral fin

			3.Avoid salt water 4.Spend nearly whole daylight in crevices of rock and seldom seen 5.Adults exclusively piscivorous, prey on fish, insects, crustaceans, molluscks 6.Efficiency of catching prey cat fish is maximized by face to face attack
Family Cichlidae	***Oreochromis niloticus* (Linnaeus, 1758)**	Nile tilapia, ‘‘Koroso’’ in Amharic	1.Depth of body 2to 23/4 times in total length, length of head 23/4 to 31/4 times 2.Mouth moderately large ½ to 2/3 width of head, extending to below anterior border of eye 3.Gill rakes short, 17-25 (rarely few 15) 4.Scale cycloid, 31-35 on lateral line 5.Omnivorous feeding on phytoplankton, aquatic plants, small invertebrates, benthic fauna and detritus
Family Distichondo ntidae	***Disticho dusrostratus (Gunther, 1864)*** **Synonyms:***Distichodus martini; Salmoniloticus, Salmoaegyptius*	Grass eater	1. Rounded snout 2.Scaly caudal with round lobes 3.Gray body more or less dark 4.Upper part of dorsal with black lines formed by a series of points on the inner radial membranes 5.One black spot at extremity of caudal peduncles; one orange humeral spot
Family Cyprinidae	***Labeo niloticus (Linnaeus, 1758)*** **Synonyms:***Cyprinus niloticus; Labeo niloticus* (Forsskal, 1775)	’Cuba’’ in Amharic ‘’Mangata’’ in Gumuze	1. Dorsal fin with 14-16 branched rays; 38-44 lateral lines 2.Eye perfectly lateral 3.Minute barbell concealed under the folds of skin at the angel of mouth 4.Pectoral fin nearly as long as head length.
Family Cyprinidae	***Labeo barbusgorgorensis (Bini, 1940)*** **Synonyms:***Barbus gorgorensis; Barbus intermediusgorgorensis*	Large barbs ‘’NechAssa’’ in Amharic	1. Dorsal spine =0; Dorsal fin with 11-12 soft rays; Anal spine=0 2.Eye diameter at least 1.6 times in snout length 3.Heavy pharyngeal jaw with large crushing teeth 4.Often large anal opening 5. Occur over muddy, sandy and rocky substrates

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