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Physiochemical Parameters of River Water Collected from River Bilate and Walacha, Wolaita, Southern Part of Ethiopia

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Abstract
The present study was designed to express the "water quality criteria of Rivers Bilate and Walacha" and analyzed for assessment of water temperature, pH, electrical conductivity, total dissolved solids, dissolved oxygen, total hardness, alkalinity, ammonia, sodium and potassium ions, lead, copper, zinc and nickel for a period of six months starting from February up to August 2018. The physicochemical parameters remained within the safe limits throughout the study period. However, Lead exceeded the limits permissible for drinking water quality parameters. The determined results showed various physical and chemical parameters ranged, temperature (16-21°C), pH (6.905-7.7), electrical conductivity (160--323 mg/l), total dissolved solids (139--222mg/l), dissolved oxygen (6.75 - 8.05mg/l), total hardness (90 - 129mg/l), alkalinity (65.5-80mg/l), ammonia (0.4-1.6 mg/l), sodium ions (10.25-14.15ppm), potassium ions (3.15-3.6ppm), lead (0-0.85ppm), copper (0-0.145ppm),zinc (0.05-1.05ppm) and nickel (0-0.11) are within permissible limits of Compulsory Ethiopian Standard for Pure Water Specification. It is also concluded that all the physicochemical parameters showed the safe range according to water quality standards of American Public Health Association.
Keywords: Bilate and Walacha Rivers, Physicochemical Parameters, Total Hardness, Electrical Conductivity
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1. Introduction

1.1. Background of the study

Water is one of the most important and abundant compounds of ecosystem. It is an essential component of human life and it is a universal solvent which has the ability to dissolve many substances of organic or inorganic compounds. With this outstanding property, nevertheless it is almost impossible to have water in its pure form since it cannot be held up in a vacuum [1]. Water sources, including surface, ground and rain (in arid and some arid areas) are supporting drinking water supply, livestock needs, irrigation, industrial and many other commercial and domestic purposes. The quality of water sources depends on the various chemical constitutes and their concentration, which are mostly induce from natural and anthropogenic activities. In Ethiopia, there is a rapid increase in population; however the common drinking water sources are limited to wells, springs, rivers and taps. Now a day, these water sources are becoming contaminated and the contamination level is increasing, for example the expansion of industries in urban areas and agricultural practices in rural areas are the most common factors for water pollution. The study conducted in Ethiopia revealed that, the dominant sources of drinking water supply for major rural communities are from rivers and springs [2]. Hence, Water quality is a key aspect of urban and rural water supply, which may influence community attitudes, thereby potentially affecting the sustainability of water supply systems. Perceived poor water quality influences the use of water, thus creating potentials of health risks through the development of unsafe alternative sources [3].

Most of the earth's water is undrinkable. Although 70% of the planet's surface is water, almost all of it is salt water in the oceans. Only 3% of the world's freshwater are safe for drinking, and 97% of that is taken in glaciers. That leaves us with less than 1% usable water from lakes, rivers and underground sources. All living organisms on the earth need water for their survival and growth. Potable or water of good drinking quality is of the basic importance to human physiology and man's continued existence [4]. The accessibility and availability of good quality drinking water plays the most important role in both social and economic development and; it is a basic factor in guaranteeing public health, the protection of the environment and sustainable development [5].
Contaminated water jeopardizes both the physical and social health of all peoples and water born disease continue to be one of the major health problems especially in developing nations. According to WHO more than 80% of all the diseases in the world are attributed to unsafe drinking water or inadequate sanitation practices [9]. In Ethiopia over 60% of communicable disease are due to poor environmental condition arising from unsafe and inadequate water supply and unhygienic and poor sanitation practices. Three fourth for the health problem of children in the country are communicable disease due to polluted water and improper sanitation [7].

Access to safe water for drinking and sanitation is a right to every citizen, and they should be available to every human being, now and in the future [8. Although there are efforts and progress, many countries in the world met Millennium Development Goals target to water and a number of diversified and multipurpose international, regional and national governments, local and international NGOs exerted their efforts and invest huge capital every year at global scale in general and in developing countries to be extremely marginal, and almost half of the world population is without access to improved sanitation facilities and more than one billion people still lack access to improved drinking-water supplies [9].

The majority of the world's population without access to improved water supply or sanitation services lives in developing regions mainly in Africa and Asia [9]. In Ethiopia, access to improve water supply and sanitation was estimated at 54% for improved water supply (95% for urban areas and 45% for rural areas) (EDHS, 2014) and 12% for sanitation (20% in urban areas, 8% in rural areas) [9].

Unavailability of good quality drinking water is one of the worst problems in many parts of the developing nations including our country Ethiopia, particularly in rural areas, where many people lack enough water to stay healthy. Inhabitants of rural areas representing 84% of global population use unimproved sources of drinking water, such as surface water, unprotected spring, unprotected well water, and water from tanker trucks. Furthermore, people have to travel long distances to collect water and often the water that is available is not safe to drink [9].

In rural areas and villages of Ethiopia water for human consumption, drinking, bathing, washing and food preparation etc. is obtained from rivers, streams, shallow wells, springs, lakes, ponds and rainfall; which are contaminated and expose the people to various water borne disease [10].

Clean, pure and safe water can exist only briefly in nature and immediately polluted by prevailing environmental factors aided by human activities. Water from most sources is therefore, unfit for immediate consumption without some sort of treatment [11] and before water can be described as potable, it has to comply with certain physical, chemical and microbiological standards, which are designed to ensure that the water is potable and safe for drinking [12]. Potable water is defined as water that is free from disease producing microorganisms and chemical substances deleterious to health [13]. Hence treat made safe and provision of portable water to rural and urban population is necessary to prevent health hazards associated with poor drinking water [14].

1.2. Statement of the problem

Natural water bodies can be affected from different directions. One of these is industrial effluents, use of fertilizers in the agriculture, domestic sewage, and improper waste disposal practices critically influencing the environments by altering the natural constituents such as the physicochemical parameters. Even climatic change can bring considerable effect on the water bodies. In our country Ethiopian national water supply coverage in 2014 was estimated at 54% with urban water supply coverage estimated at 95% and rural water supply at only 45% [15]. The SNNPR total water coverage is reported to be 48%; among 14507098 people 6935649 have access to clean water coverage [16]. However, although this could represent significant progress, the quality of water in different parts of Ethiopia including our study area is still in question [9].

River water is one of the major sources for utilizing different purposes such as drinking for both human and cattle, washing clothes, showering and other functions in the study area hence it will be important to assess the water quality with respect to physicochemical parameters some common anions and heavy metals contents. The results will be compared with the recommendation limits of the WHO.

1.3. Significance of the study

It is quite known that, water is an essential for human being, animal and plants. Therefore, the findings of the study will provide adequate information about the current status of river water quality commonly used in the study area and it will provide adequate information for the concerned bodies. In addition, it could be used as a source document for further research work in the same area.

1.4. Objective of the study

1.4.1. General Objective

The main objective of the study is to characterize the physiochemical parameters of river water collected from River Bilate and Walacha, Wolaita, Southern part of Ethiopia

1.4.2. Specific Objective

- ✓ To determine the physical parameters (DO, TDS, EC, pH, and Temperature) and their level in rivers water using FAAS.
- ✓ To determine chemical parameters (K^+, Na^+, NH_3, Alkalinity, Total Hardness) using UV-Visible spectroscopy
- ✓ To compare the physiochemical parameters of river water between the areas.
- ✓ To recommend for concerned bodies for fish productions

2. Materials And Methods

2.1. Description of the study area

The **Bilate** is a river of south-central Ethiopia. It rises on the southwestern slopes of Mount Gurage near 6°2′N38°7′E, flowing south along the western side of the Great Rift Valley, to empty into Lake Abaya at

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6°37′54″N37°59′6″E. It founds the boundary between the Sidamo district on the eastern side, and the Wolaita district on the western side. It is the major river found in the Wolaita zone and hence, it has high probability to be contaminated by pesticides of interest because it crosses long distance from the woreda around there including farm lands on which pesticides have been applied. The **Walacha** is also river of South-central Ethiopia, which founds near Bodity town on Northern part of the Wolaita Zone. It has also high probability to be contaminated by pesticides due to densely populated people uses farm lands for different purposes.

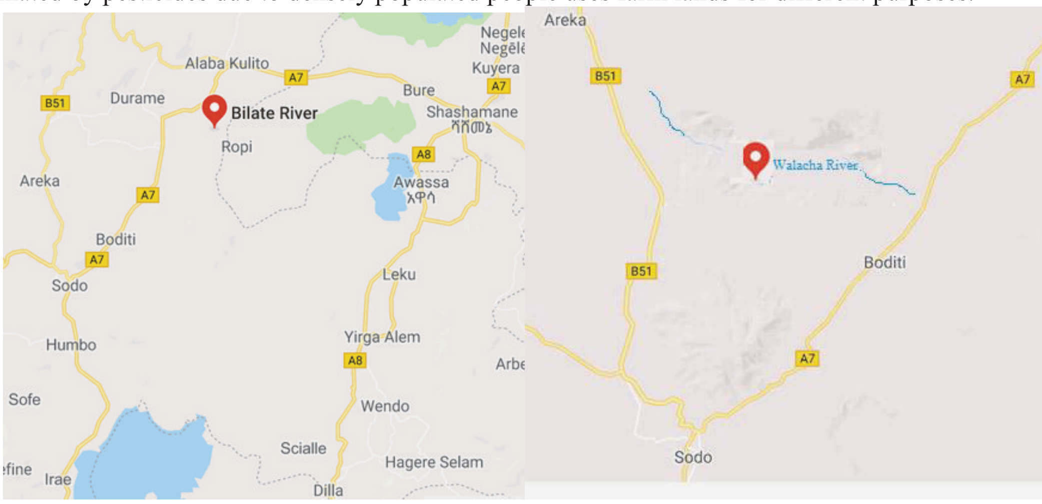

Fig. 1: Map of Rivers

2.2. Apparatus used

Flame atomic absorption spectrometer, Uv-Visible spectrometer, centrifuge, volumetric flask, conical flask, electronic balance, electrical oven, polypropylene bottles, muffle furnace, pippets, beakers, hot plate electrical heater, thermometer, and crucible was used.

2.3. Water Samples Collection

For physiochemical parameters the water samples were collected from the specific stations Walach, and Bilate as shown in Fig 1, on monthly basis in plastic bottles having a 1 liter capacity from February to August, 2017/18. The bottles were first washed with detergent thoroughly, then with tap water and after that washed with sampling water three times. Water samples were directly collected from a main river area having a minimum depth of two to three feet. Water samples were brought to the Wolaita sodo Universtiy chemistry laboratory room and Addis Ababa University chemistry laboratory for determining the physical parameters and chemical parameters respectively.

2.3.1. Physical Parameters

Temperature: The digital centigrade thermometer was used for detection of water temperature at the time of water sampling. Water temperature was recorded by dipping the thermometer in sample water and waited for about three to five minutes.

pH: The pH of sample water determined by pH meter model 320. First tested the pH meter with distilled water and calibrated to zero. Then tested it with standards having pH 4 and pH 7 and pressed calibrate button. Then, the electrode of pH meter washed with distilled water. The sample water 25 ml was taken in a beaker and pH meter electrode dipped in and noted the reading directly from the screen.

Electrical Conductivity (EC): Electrical conductivity of sample water determined by conductivity meter (Digital instrument Indian made).

Total Dissolved Solid (TDS): Total dissolved solid of sample water was detected by TDS meter (Digital instrument Indian made).

Dissolved Oxygen (DO): For determination of dissolved oxygen of sample water, DO Meter was used.

2.3.2. Chemical Parameters

Total Hardness: Titrimetric method was used to determine the total hardness of sample water. A conical flask was rinsed with sample water three times. Then taken 25 ml of sample water and added 1 to 2 ml of buffer pH 10 (67.5g NH_4Cl in 570ml conc. NH_4OH), then added indicator Erichrome Black T (0.5g sodium salt of 1-(1-hydroxy-2-naphthylazo)–5nitro-2naphthanol-4sulfonic acid dye in100g Triethanolamine) and shaked well. Titrated it with Ethylene Diamine tetra Acetic acid (EDTA) of 0.01 N until the color was changed to pink.

$$Total\ hardness = \frac{Vol.of\ used\ std.x\ con.of\ std.sol\ x\ mol.wt\ of\ CaCO3}{Vol.used\ of\ sample\ water}\ x\ 100$$

Alkalinity: Alkalinity of water was determined by titrimetric method. A conical flask was taken and washed with distilled and sample water. Then 25 ml of water sample was taken and added three to four drops of methyl orange. Titrated it against 0.02 N H_2SO_4 until the color of sample water was changed from orange to blue. Reading was noted directly from burette and used the same formula as for total hardness

$$Alkalinity = \frac{Std.\,\text{Sol.Vol. use} \times \text{Std. Sol. Con.} \times \text{Molecularweight of CaCo4}}{Used\ sample\ water\ volume}\ x\ 100$$

Ammonia NH_3: For determination of ammonia UV spectrophotometer was used. Ammonia concentration of sample water was determined by the direct nesslerization method. First took 5 volumetric flasks of 100 ml volume and written down on them 0, 2, 4, 6 and 8. Then added distilled water and standard solution of ammonia in each. In volumetric flask 0 didn't add any standard of ammonia, in volumetric flask 2 added 2ml of standard solution of ammonia, in 4 added 4 ml, in 6 added 6 ml and in 8 added 8ml of standard of ammonia. Then added 5 ml of nesslers reagents into each of them and dilute to 100 ml with distilled water. Sample water of 50 ml was taken in a volumetric flask and added 5 ml of Nessler reagents and diluted with distilled water to 100 ml and waited 30 minutes. Adjust the UV spectrophotometer at 420 nm wavelength. One of the two UV flasks was filled with distilled water and the other was filled from volumetric flask 2, 4, 6 and 8 in a series. A standard curve was formed by plotting absorbance against a standard solution of ammonia. Then the second flask was filled from sample water and noted the absorbing reading and used the following formula for calculating the ammonia concentration in sample water.

$$NH_3{-}H\left(\frac{Mg}{L}\right) = \frac{mg\ NH3 - x\ 1000}{Sample\ volume}$$

Sodium Ions (Na^+) and Potassium Ions (K^+): Flame Photometer was used for determination of sodium and potassium ion, concentrations. First checked flame photometer with distilled water and adjusted to zero by adjuster button. Then checked it with standard solutions. For sodium ions (Na^+) 40 ppm and for potassium ions (K^+) 20 ppm standard were used and adjusted it by fine adjuster. Sample water of 50 ml was taken in a beaker. Dip the flame photometer electrode in sample water and was noted the reading directly from the screen.

Heavy Metals (Pb, Cu, Zz and Ni)

Digestion Process: 100ml of sample water was taken in a beaker and added 5ml of nitric acid (HNO_3). Then the beaker kept on a hot plate and waited until 50 ml were remained. Then added 20 ml distilled water and 5ml of HNO_3 and kept again on a hot plate. Waited until 30 or 40ml was remained. Then the digested sample transferred to 100 ml volumetric flask and added distilled water up to 100ml mark. Then it was prepared for determining in atomic absorption.

3. Results

3.1. Physical Parameters

Temperature (°C): During the current study temperature was recorded almost same at different areas. The maximum (21°C) average temperature was recorded in the month of March while minimum (16 °C) was determined in the month of August. The temperature ranged from 16 to 21°C. At both areas, Walacha and Bilate rivers, the recorded temperature in the months of February, April, June and July were 19, 20, 16.5 and 17.5°C respectively. (Table 1).

pH: Throughout the study period, no such clear variation in pH values was recorded. The highest mean (7.70) value of pH was observed in the month of August at the same time as lowest mean (6.90) value of pH was measured in June month. At Walacha station the pH value ranged from 6.89 to 7.08. The highest (7. 08) pH value was recorded in August and lowest (6.89) in June. The pH value 7.1, 7.13, 7.23 and 7.62 were detected in the months of July, March, April and February respectively. The pH value at Bilate station was ranged from 6.88 to 7.05. The highest (7.08) pH value was recorded in August and lowest (6.88) in April. The pH values recorded at the rest of the month were 6.09, 6.92, 7.22 and 7.55 in March, June, July, and February respectively. (Table 1).

Electrical Conductivity (µs/cm): The highest average (310 µs/cm) electrical conductivity was recorded in the month of July while the lowest average (160.5µs/cm) electrical conductivity determined in March. At Walacha station the maximum (300 µs/cm) electrical conductivity was recorded in July and the minimum (150µs/cm) in June. Electrical conductivity values 154, 156, 210 and 240µs/cm were recorded in March, August, February and April respectively. On Bilate station the maximum (320µs/cm) electrical conductivity was recorded in July and the minimum (167µs/cm) was recorded in March. The EC value 230, 240, 256 and 290µs/cm was recorded in the months of February, June, April and August respectively (Table 1).

Total Dissolved Solids (mg/L): The maximum mean (222mg/L) value of total dissolved solids was measured in July whereas minimum mean (139mg/L) value was noted in the month of February. Total dissolved solids (TDS) ranged from 136 to 210mg/L at Walacha station, at Bilate station it ranged from 134 to 234mg/L. At Walacha station the highest (210mg/L) TDS value was recorded in July and lowest (136mg/L) in February.

The TDS value 155mg/L was recorded in the months of April and August and 165mg/L and 191mg/L were recorded in the months of March and June respectively. On Bilate station the highest TDS value (234mg/L) was recorded in July and the lowest (134mg/L) in April. Total dissolved solid values 142, 163, 164 and 178mg/L were recorded in February, August, March and June respectively. (Table 1).

Dissolved Oxygen (mg/L): The minimum average (6.75mg/L) concentration of dissolved oxygen was noted in the month of March while the maximum average (8.05mg/L) concentration of DO measured in month of June. At Walacha station the highest (8.3mg/L) dissolved oxygen value was recorded in April and lowest (6.5mg/L) in August. Dissolved oxygen value 7.2mg/L were recorded in February and March, 6.9 and 8.2mg/L were determined in the months of July and June respectively. At Bilate station the minimum (6.3mg/L) dissolved oxygen value was recorded in March and maximum (7.9mg/L) in June. In the months of February, April, July and August dissolved oxygen values were recorded 6.8, 7.3, 6.8 and 7.1mg/L respectively. (Table 1).

Table 1: Physical water quality parameters and their mean ± SD at both stations

Parameters	Stations (Area)	Months						STD	WHO standards	P-Values
		Feb	March	April	June	July	Aug			
Temperature (^{0}C)	Walacha	19	21	20	16	17	16	2.13		
	Bilate	19	21	20	17	18	16	1.87	-	0.0000
	Mean	19	21	20	16.5	17.5	16	1.99		
pH	Walacha	7.62	7.13	7.23	6.89	7.11	7.8	0.34		
	Bilate	7.55	6.9	6.88	6.92	7.22	7.6	0.33	6.5-8.5	0.7023
	Mean	7.585	7.015	7.055	6.905	7.165	7.7	0.32		
EC $\mu s/cm$	Walacha	210	154	240	150	300	156	60.39		
	Bilate	230	167	256	240	320	290	52.70	800-1000	0.0020
	Mean	220	160.5	248	195	310	323	50.66		
TDS mg/L	Walacha	136	165	155	191	210	155	27.06		
	Bilate	142	164	134	178	234	163	35.55	1000	0.0033
	Mean	139	164.5	144.5	184.5	222	159	30.56		
DO mg/L	Walacha	7.1	7.2	8.3	8.2	6.9	6.5	0.72		
	Bilate	6.8	6.3	7.3	7.9	6.8	7.1	0.54	4.0-6.0	0.0011
	Mean	6.95	6.75	7.8	8.05	6.85	6.8	0.57		

Table 2: Chemical water quality parameters and their mean ± SD at both stations

Parameters	Stations (Area)	Months						STD	WHO standards	P-Values
		Feb	March	April	June	July	Aug			
T. Hardness (mg/L)	Walacha	82	102	124	105	111	128	16.63		
	Bilate	98	123	98	96	145	130	20.63	300-600	0.0032
	Mean	90	112.5	111	100.5	128	129	15.24		
Alkinilaty (mg/L)	Walacha	70	70	82	81	65	60	8.71		
	Bilate	65	68	78	79	70	71	5.56	200-600	0.0003
	Mean	67.5	69	80	80	67.5	65.5	6.61		
Ammonia (mg/L)	Walacha	1.1	1.2	0.9	0	1.7	1.9	0.67		
	Bilate	0.9	0	0	0.8	1.5	0.7	0.57	0.2-0.5	0.0037
	Mean	1	0.6	0.45	0.4	1.6	1.3	0.79		
Sodium Na^+ (ppm)	Walacha	8.9	9.5	11	13.2	10.4	14.1	1.64		
	Bilate	13.2	11	11.5	12.6	13.9	14.2	1.03	200	0.0375
	Mean	11.05	10.25	11.25	12.9	12.15	14.15	1.10		
Potassium K (ppm)	Walacha	3.1	3.5	2.8	2.9	2.5	3.3	0.28		
	Bilate	3.8	3	3.5	4	4.2	3.9	0.32	10	0.0185
	Mean	3.45	3.25	3.15	3.45	3.35	3.6	0.12		

3.2. Chemical Parameters

Total Hardness (mg/L): The highest mean (129mg/L) value of total hardness was noted in the month of August while the lowest mean (90mg/L) value was determined in February. At Walacha station maximum (128mg/L) total hardness value was recorded in August and minimum (82mg/L) in February. Total hardness values were recorded 102 and 124mg/L in March and April and 105 and 111mg/L in June and July respectively. At Bilate station the highest (145mg/L) total hardness value was recorded in July and the lowest (96mg/L) in June. Total hardness values were 123 and 130mg/L were recorded in the months of March and August and 98mg/L value was recorded in Febraury and April respectively. (Table 2)

Alkalinity (mg/L): The highest average (80mg/L) alkalinity was recorded in the month of both April and June while lowest (65.5 mg/L) was measured in the month of August. At Walacha station alkalinity ranged from 60 to 82mg/L, at Bilate station it ranged from 65 to 79mg/L. At Walacha station the highest (82mg/L) and lowest (60mg/L) alkalinity values were recorded in April and August. Alkalinity value 70mg/L was recorded in the months of February and March. In June and July alkalinity values were recorded 81 and 65mg/L. At Bilate station highest (79mg/L) alkalinity value was recorded in June and lowest (65mg/L) in February. Alkalinity values 68, 78, 70 and 71mg/L were determined in March, April, July and August respectively. (Table 2).

Ammonia (mg/L): The maximum average (1.6mg/L) ammonia concentration was determined in the month of July at the same time as the minimum average concentration (0.4mg/L) was observed in June. At Walacha station higher value (1.9mg/L) was recorded in August and lowest value (0) was recorded in June. The ammonia concentrations were 1.1, 1.2, 0.9 1.7 mg/L recorded in February, March, April and July respectively. In Bilate station the minimum (0) value was recorded in the months of March and April while the maximum value was (1.5 mg/L) in July. In February, June and August the concentration of ammonia values were 0.9, 0.8 and 0.7 mg/L respectively were observed. (Table 2).

Sodium Ion (ppm): The overall maximum mean (14.15ppm concentration of sodium ions was noted in the month of August while overall minimum mean (10.25ppm) concentration of sodium ions was detected in March. At Walacha station the highest (14.1ppm) sodium ion concentration was recorded in August and lowest (8.9ppm) in February. Sodium ions concentration values 9.5, 11, 13.2 and 10.4ppm were noted in the months of March, April, June and July respectively. At Bilate station the highest (14.2ppm) sodium ions concentration was recorded in August and the lowest (10.25ppm) in March. While in February, April, June and July the values of sodium ion's concentration values recorded were 13.2, 11.5, 12.6 and 13.9ppm respectively. (Table 2).

Potassium ion (ppm): The highest average (3.6ppm) of potassium ions concentration was observed in the month of August while lowest overall average (3.15ppm) potassium ions concentration was noted in April. At Walacha station the minimum (2.5ppm) of potassium ion concentration was recorded in July and maximum (3.5ppm) in March. Potassium ions concentration values 3.1, 2.8, 2.9 and 3.3ppm were recorded in the months of February, April, June and August respectively. At Bilate station the highest (4.2ppm) potassium ions concentration was recorded in August and the lowest (3ppm) in March. Potassium ion's concentration values 3.8, 3.5, 4 and 3.9ppm were recorded in February, April, June and August respectively.

Table 3: Different concenterations of heavy metals in water and their mean ± SD in all stations

Parameters	Months							STD	CESPWS standards	P-Values
	Stations (Area)	Feb	March	April	June	July	Aug			
Nickel (Ni) (ppm)	Walacha	0.12	0.11	0	0	0	0	0.059		
	Bilate	0	0	0	0	0.16	0.12	0.073	0.1	0.000
	Mean	0.06	0.055	0	0	0.08	0.06	0.034		
Zinc (Zn) (ppm)	Walacha	0	0	0.1	0.11	0.25	0.6	0.22		
	Bilate	0.1	0.8	0.91	0.89	1.2	1.5	0.46	5	0.0002
	Mean	0.05	0.4	0.505	0.5	0.725	1.05	0.33		
Lead (pb) (ppm)	Walacha	0	0	0	0	0.67	0.90	0.41		
	Bilate	0	0	0	0.2	0.54	0.80	0.33	0.01	0.0136
	Mean	0	0	0	0.1	0.605	0.85	0.37		
Copper (Cu) (ppm)	Walacha	0.07	0.09	0	0	0	0	0.04		
	Bilate	0.12	0.2	0	0	0	0	0.08	2	0.0234
	Mean	0.095	0.145	0	0	0	0	0.06		

Compulsory Ethiopian Standard for Pure Water Specification (CESPWS)

Heavy Metals

Lead (Pb): Negligible amount of heavy metals was recorded from Rivers during the study period. The highest average (0.85ppm) concentration of lead was noted in the month of August while the lowest average (0) overall concentration was recorded during the month of February up to April. At Walacha station the lead concentration was zero during the month of February, March, April and June. While at Bilate station 0.2, 0.8 and 0.54 values was recorded in June, August and July respectively. In the rest of month it was not detected(Table 3).

Copper (Cu): The maximum (0.145ppm) mean concentration of copper was noted in the month of March while minimum (0) mean concentration of copper was observed in the months of April, June, July and August respectively. At Walacha station only small concentration of copper (0.07 and 0.09) was recorded in the months of February and March respectively while in the rest of the month copper was below the detection level. At Bilate station copper concentration (0.12) and (0.2) were detected in February and March and while the rest of the month copper was below the level of detection. (Table 3)

Zinc (Zn): Overall highest average (1.05ppm) concentration of zinc was recorded in the month of August while overall lowest average (0.05) concentration of zinc was measured in the month of February. At Walacha station zinc concentration was very low. Highest (0.6) zinc value was recorded in August and lowest value zero in the months of February and March. Zinc values of 0.1, 0.11 and 0.25 were detected in the months of April, June and July. At Bilate station maximum (1.5) zinc value was recorded in August while minimum (0.10) value was recorded in the month of February and 0.8, 0.91, 0.89 and 1.2 zinc concentrations were recorded in the months of March, April, June and July respectively. (Table 3)

Nickel (Ni): The highest mean (0.08ppm) concentration of nickel was observed in the month of July at the same time as lowest mean (0) concentration of nickel was noted in the months of July, April and June. At Walacha station highest (0.12ppm) concentrations of nickel was recorded in the month of February. In the months of April, June, July and August it was below the level of detection. While at Bilate station maximum (0.16ppm) value of nickel concentration was recorded in the month of July and minimum zero was recorded in the months of February, March, April and June 0.12ppm was recorded in August. (Table 3).

4. Discussion

The physicochemical characteristics of water are enormously influenced by the richness of biota, its uses and distribution [17]. The physicochemical parameters which affect the aquatic ecosystems are dissolved oxygen, temperature, pH, rainfall and salinity, etc. Such parameters are the restraining factors for the continued existence of aquatic fauna and flora [18]. Freshwater ecosystem is subject to difference in the environmental factors such as temperature, pH, dissolved oxygen turbidity, density, light penetration, etc. Such parameters play vital role for the distribution and abundance of aquatic organisms in different freshwater ecosystems, according to their adaptation manner, which allow them to live in definite ecosystems [19]. While the distribution and abundance of fishes entirely depend on physical, environmental condition and the level of tolerance, which fish potential to survive under sudden environmental variations more or less [20].

The present study showed various physical and chemical water quality parameters found within permissible limits of Compulsory Ethiopian Standard for Pure Water Specification [21].

In the present study maximum temperature of 21 °C in March and minimum was 16 °C in August. The same result was recorded by Ashraf [22]. In the present study pH values were reported in the range of 6.905 to 7.7 which are suitable for fish production and survival. Measurement of PH is one of the most important and frequently used tests in water chemistry. Although, the Ethiopian Drinking water standard has set an allowable PH value ranges from 6.5 to 8.5 (ES 2001),[23] it is known that PH is more important as operational water quality parameters than its impact on consumers. During the present study the minimum value of (160.5µS/cm) of electrical conductivity was recorded in March and maximum (310 µS/cm) in July. Electrical conductivity showed variations during the study period, such variations might be due to different factors such as salinity, dissolved solids, the concentration of free ions; high level of industrial waste, temperature, etc. Similar results are reported by Boyd [24].

Total dissolved solids (TDS) designated the total quantity of carbonates, sulfates, bicarbonates and some other inorganic components in water. For diverse fish population the maximum total dissolved solid values as 400mg/L [25]. During present investigation TDS values ranged from 139 to 222mg/L. Total dissolved solid values were minimized (139mg/L) in August and high and maximum (175mg/L) in February it is within the permissible limits of WHO [26].

Minimum (6.75 mg/L) value of dissolved oxygen was reported in March and maximum (8.05 mg/L) in June during the present study. Dissolved oxygen is inversely proportional to water temperature and photoperiods, with a high value of temperature and long photoperiod dissolved oxygen showed minimum values. When low temperature and short photoperiod the dissolved oxygen showed maximum values. In March the temperature was high and dissolved oxygen was low, in June the temperature was low and oxygen was high. Similar results were observed by Ali *et al.* [27]. Water hardness is mainly caused by the presences of iron, magnesium and calcium ions and also because of Al, Zn, Mg, Ni and some other heavy metals in water. Hardness value lower than 5 mg/L cause death of fish, at values less than 15 mg/L growth rate of fish becomes slower and more than 15 mg/L is suitable for fish production [24]. In the present investigation the minimum (90.00mg/L) value of hardness was observed in February and maximum (129mg/L) in August. Hardness fluctuated from February to August was due to seasonal changes.

During the present observations alkalinity was reported in the range of 65.5-80 mg/L. Minimum 65.5mg/L value of alkalinity was reported in August and maximum 104 mg/L in April and June it was within the range of WHO [26]. Our result was compared to WHO guidelines. The total alkalinity of water collected from both of the sampling sites was lower than the permitted value by WHO guidelines (>200 mg/L) which could be ascribed to low carbon dioxide concentration. The highest concentration of ammonia is toxic to aquatic organisms. During the present investigation ammonia ranged from 0.4-1.6 mg/L at both stations. The minimum value was 0.4 in June and maximum (1.6 mg/L) was in July. The high concentration of ammonia in water may be due to low flow and less volume of water. Sodium and potassium ions mean concentrations between the range of 10.25 – 14.15ppm and 3.15-3.60ppm was reported during the present study. Similar results were investigated by Ali *et al*. [28] from Ghazi Ghat, Indus River.

Fish growth is a dependable and the susceptible endpoint in constant toxicological examination [29]. During the present analysis heavy metals Pb, Cu, Zn and Ni were found in the range of 0-0.85, 0-0.145, 0.05-1.05 and 0-0.08ppm, respectively. These heavy metals are detected within safe limits except lead. Lead exceeds (CESDWS) [30] standards for drinking water quality. It means that city sewage contains Ni and Pb which are exceeding the quantity of these metals in river water making it unfit for drinking. Prolong exposure of fish in the particular area will be having life threats also especially the Juvenile and eggs. Furthermore, in the result of bioaccumulation of these metals within the fish body can pose human health problems in the case of consumption of of such fish the presence of Pb and Ni in water could potentially pose health threats to humans either via through direct consumption of surface water or bioaccumulation process [31].

The source of heavy metals (Cu and Zn) in fresh water bodies is mainly through industrial effluents. In freshwater bodies, the acceptable level of copper is 2.0ppm and zinc is 3.0ppm [32]. Higher concentration will be life threatening. The present study reports that the concentrations of Cu and Zn were within the safe limits (Table 3).

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