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Research article

Physicochemical characterization of effluents from industries in Sabata town of Ethiopia

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ABSTRACT

Untreated industrial effluents have often caused environmental pollution and human health concern. This study analyzed the pollution of wastewater from some selected industries in the Sabata town of Ethiopia. The composite sampling techniques were used to collect wastewater from industries in dry (April–May) and wet (June–July) seasons and analyzed physicochemical properties using atomic absorption spectrophotometry. All parameters investigated were analyzed using mean and Analysis of Variance. The results depicted that the conductivity, biological oxygen demand, chemical oxygen demand, and pH were all beyond the safe limits of World Health Organization along the studied Sabata River and industries. This indicates pollution of the water that not apt for drinking, farming, and industrial uses. Furthermore, the electrical conductivity, biological oxygen demand, chemical oxygen demand, total suspended solid, total nitrogen, and total phosphorus were statistically significant ($p < 0.05$), which indicates the disruption of river water quality by industrial effluents. Therefore, the government should take this into account and devise mitigation strategies through enforcing existing standard of industrial pollution control regulation, installation of treatment plant, transforming of industrial residual into biogas products, awareness creation for the society, initiation of sustainable corporate industrial responsibility, and the implementation of environmental protection regulation.

1. Introduction

Industrial pollution is as old as the civilization that poses a threat to the health and wellbeing of millions of people and the global ecosystem (Priscilla, 1999). With modern civilization, wastes are generated primarily from industries. Specifically, water pollution arising from unprecedented waste disposal of industries in developing countries needs a due concern (Bhuyan and Islam, 2017; Ahmed et al., 2019). Industrial wastes were estimated to be 50 % of all the pollutants and contaminated wastes discharged into the environment (Kpelle et al., 2014). Thus, environmental pollution wrecks could have an adverse effect on both human being and aquatic biota (Landrigan et al., 2018).

The study carried out by Abdel-Shafy and Mansour (2018) in 4 continents, 22 countries, and 30 urban areas revealed that an immense effect of municipal wastes on the environment. This study also showed that paper (27%), food (15%), yard trimming (14%), plastics (13%), metals (9%), rubber, leather and textiles (9%) and others (3%) in the United States of municipal wastes contribute to environmental disaster (Abdel-Shafy and Mansour, 2018). This indicates the negative effects of wastes on the environment due to inappropriate waste management system. The industrial wastes had also caused a change in the ecosystem values, pH, conductivity, and trace metals (Priscilla, 1999). Similarly, a consistent economic growth (GDP) rate since 2001 in Sub-Saharan Africa had brought about increasing environmental risks and depletion of ozone layer due to increase in anthropogenic activities (Dodman et al., 2013). Therefore, the impact of industrial wastes on environmental resource loss had to be counterbalanced with resource gain that can be used by society but not individuals (Enetjärn et al., 2015).

Recently, the increase of industrial wastes in developing countries is demanding a waste management system. The sustainable development goals highlight the adoption of clean and environmentally sound technologies and industrial processes to get water free from chemical contamination (UN, 2017). In Ethiopia, water free from chemical contamination was estimated to be 13 % (Central Statistical Authority (CSA), 2017). Other studies further state that textile industry in Ethiopia might be a largest source of water contamination due to many textile

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industries operate without treatment plants and discharge their effluents directly into river bodies (Sima and Restiani, 2017). Other studies reaffirmed that Akaki River was highly contaminated because of the discharge of the partial treated or untreated industrial effluents into the river (Amare, 2019).

Most of the industry promoters in Ethiopia misconceived as costly to prepare and implement EIA (Damtie and Bayou, 2008). As a result, many factories in the Akaki industrial zone had not appropriately managed their industrial effluents and disposed their wastes to immediate environment without any precaution (Aregawi, 2014). Previous studies showed that the dust discharged from the industries affect the physiochemical properties of the soils in the area (Estifanos and Degefa, 2012; Assefa and Ayalew, 2014).

Several industries in Sabata town are located close to Sabata River and within residential areas. These industries often discharge either untreated or only partially treated wastes openly into the environment, and affecting the local community health, livestock, wetland, and vegetable farms. The pollution of surface water may result in a high concentration of physicochemical that may disrupt the environment. Some studies were conducted in Ethiopia to explore the concentration level of the physiochemical properties of effluents from industrial activities. However, there is paucity of information on the spatial and seasonal variation of the physicochemical parameters of effluents discharged from industries in Sabata. Therefore, this study was aimed to analyze of physicochemical characteristics of effluents from some selected industries in Sabata town of Ethiopia.

2. Materials and methods

2.1. Description of the study area

The study was carried out in Sabata town, which is about 24 km distance in the Southwest part of Addis Ababa city. It is located between $8^0 53'39''$ N to $8^0 59'58''$ N latitude and $38^0 35'12''$ E to $38^0 39'34''$ E longitude. The altitude of the town ranges from 2,060 to 2,670 m above sea level. Agro-climatically, the town has a temperate climatic condition with a temperature ranging from 12.7 °C to 24.4 °C. The total land size of the town was 2.1 Km^2 (1994), 7.41 Km^2 (2011), 9.9 km^2 (BoFEDO, 2014/15) and 17.5 Km^2 (OUPI, 2019). This indicates an increasing trend of the urban land size used for industry development and other development activities. According to the information acquired from Sabata Investment Office, operational manufacturing industries were allocated a land size of 145.85 ha in the town.

2.2. Study design

The design of this study followed WHO drinking water guidelines, and American Public Health Association (APHA) guidelines (APHA, 1999). Accordingly, the samples of industry were collected for analysis of physicochemical properties (temperature, pH, electrical conductivity, COD, BOD, TSS, TN, TP, and ammonia). The physicochemical properties were measured following the procedures outlined by the American Public Health Association (APHA, 1999).

The temperature and pH values were measured in-situ, and other physicochemical parameters tests were done at the Environmental Laboratory of Addis Ababa City Environmental Protection and Green Development Commission. Data for physicochemical properties (2016–2018) of industries were obtained from Sabata town Environment, Forest, and Climate Change Authority (EFCA). The collected data for the year 2016–2018 was from the same industries data except upstream (control) and downstream and collected data on two seasons (dry and wet season) in 2019. Data from Sabata river was collected following riverbank from three location such as upper stream (no industry), middle stream (industry start) and downstream in dry and wet season.

2.3. Sampling techniques

The criteria for sampling sites selection was based on baseline setting of the upper stream Sabata River (control), and the treatment group (middle stream and downstream) as well as wastewater from industry (treatment) and upper stream (control). The sampling sites were marked using GPS reading and GIS mapping for sampling sites (Figure 1 and Table 1). The composite sampling techniques were utilized to collect wastewater from industries in dry (April–May) and wet (June–July) seasons and quantified physicochemical properties using graphite atomic absorption spectrophotometry. While, water temperature, and pH were quantified in-situ. The sample from Sabata river (one liter), and effluents (one liter) were collected in plastic bottles washed with nitric acid and distilled water before sample collection.

The physicochemical parameters such as temperature, EC, ammonia, COD, TP, TN,TSS, pH, and BOD were analyzed using pH meter of VWR pH110 (range -10.0 to 120 °C, accuracy ±0.5 °C, and resolution 0.1 °C), conductivity meter, Nessler method, reactor digestion method, ascorbic acid method, Kjeldahl method, photometric method, pH meter of VWR pH110, and sensor method. The quality assurance was made using quality control methods such as standard protocol, washing plastic bottles, calibration, analysis of reagent blanks, de-ionized water, and standard solution.

2.4. Quality assurance

The analysis instrumental parameter deployed following the burner 100 mm, HCL lamp, and single beam optical mode. The blank limit assumes sample containing no analyst or contrition of analyst 0 unit, which means zero level of calibration. The Atomic absorption spectrophotometry (analytikjena, German, type NOVAA 400P) was used. The method of detection implies sample contain low contrition of analyst, dilution of lowest contrition of calibrator or Analytical Jena NOVAA 400. The flame method was used with 10-4 mg/L. The quantification limit sample was containing low concentration of analysis at the expected limit of quantification for NOVAA 400 10-4 mg/L or above its base limit. The physiochemical parameters of industrial wastewater and river water were examined and quantify the level of physiochemical by using AAS.

2.5. Statistical analysis

The physicochemical data were recorded, organized, and analyzed using R software (version 3.4) and Microsoft Excel. The physicochemical properties values were compared with World Health Organization (WHO), World Bank (WB), United Nations Industrial Development Organization (UNIDO), India Standard Institute (ISI), Bureau of Indian Standards (BIS), Federal Democratic Republic of Ethiopia Environmental Protection Agency (FDRE EPA), National Water Quality Standards (NSDWQ) of Malaysia, Indian Council for Medical Research (ICMR), World Health Organization (WHO), UK General Quality Assessment (UK GQA), and Canadian Council of Minister for Environment (CCME) standard for water quality and interpreted as above permissible limit or not. The data were analyzed with one-way Analysis of Variance (ANOVA), mean, and standard deviation and statistically significance when $P < 0.05$ using R software (version 3.4).

3. Results

3.1. Analysis of physicochemical properties of industrial effluents (2016–2018)

3.1.1. Temperature and pH

The water temperature of samples ranged between 21 and 37.2 °C (Table 2) which was above the permissible limit recommendation by UNIDO (15 °C), CCME (15 °C), and WB (15 °C). The pH value of the

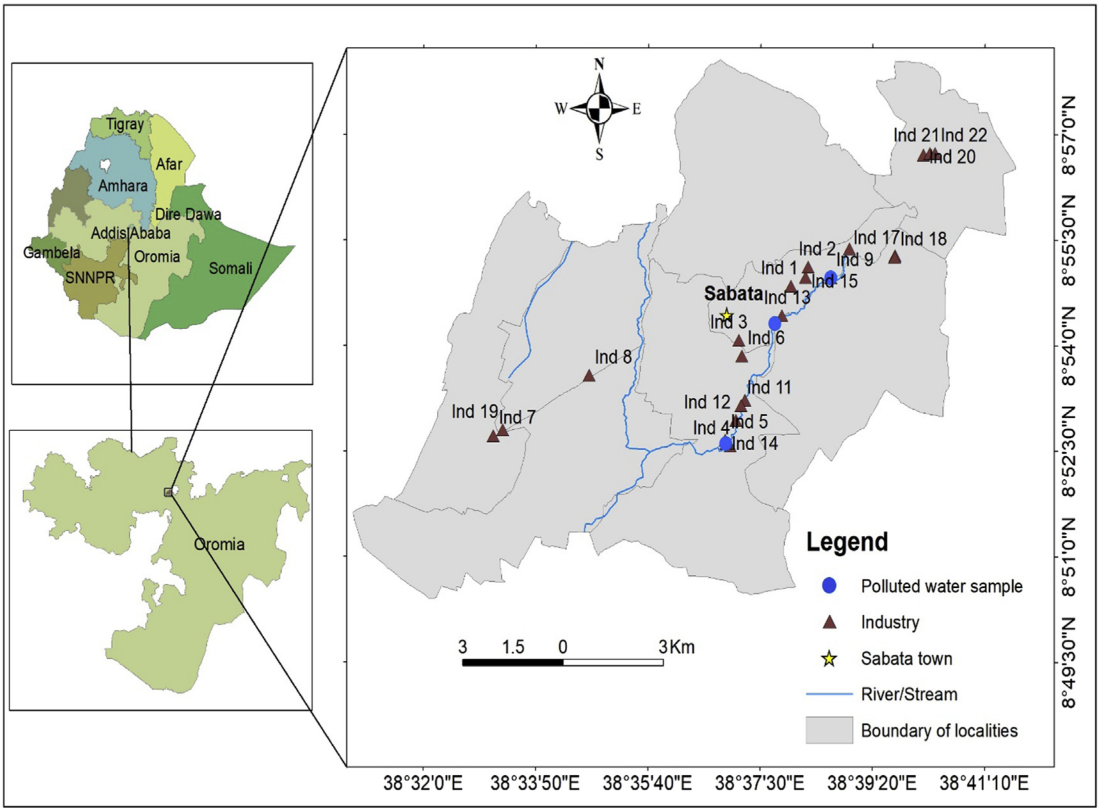

Figure 1. Map showing the distribution of sampling sites.

Table 1. The coordinate of sampling points.

Industry	Description	Lat.	Long.
Ind 1	National Alcohol and liquor factory	8.914131	38.63333
Ind 2	Balezaf alcohol and liquor	8.918617	38.63804
Ind 3	Industrial wastes release on surface around Atebella Chaffe	8.901227	38.61922
Ind 4	Sabata river atbela	8.876256	38.6169
Ind 5	Nova water	8.877615	38.6155
Ind 6	Meta Abo Brewery S,c	8.897578	38.62006
Ind 7	Yes mineral water plc	8.878635	38.55236
Ind 8	Yes Brands and Beverages	8.892947	38.57842
Ind 9	Arba Minch textile plc	8.916143	38.6442
Ind 10	Zalash cosmetics and plastics	8.887058	38.62081
Ind 11	Sabata Abattoir	8.885746	38.61985
Ind 12	Steel smelting factory	8.882298	38.61839
Ind 13	Arba Minch textile factory	8.907067	38.63088
Ind 14	Plastic industries	8.876844	38.6157
Ind 15	Pacific industrial Plc	8.916174	38.63735
Ind 16	Hafde Tannery	8.922916	38.64924
Ind 17	Walia steel industry	8.921362	38.66173
Ind 18	Ayka Addis textile and Investment group	8.920971	38.6616
Ind 19	Home Tech factory	8.880072	38.55494
Ind 20	HPM modern pipe plastic	8.945262	38.66943
Ind 21	Cable factory	8.945594	38.67112
Ind 22	Cement industry	8.945532	38.67258

alcohol and liquors, and tannery industries were 4.0 and 4.7 log units, respectively. The pH value of effluents from alcohol and liquors, and tannery were acidic. Whereas, the pH value of brewery was alkaline (Table 2). The pH value of tannery, and liquors and alcohol industries were not within the permissible limits recommended by WHO (6.5–9.2). The low pH concentration values were recorded in alcohol and liquors, and tannery, respectively. This low pH depicts that a high acidity with high chemical toxic pollution of the environment.

Table 2. Analysis of physicochemical parameters of industries (2016–2018).

Year	Industries	Temperature (^{0}C)	EC, µs/cm	pH	BOD, mg/L	COD, mg/L	TSS, mg/L	Ammonia, mg/L	TN, mg/L	TP, mg/L
2016	Arbamich Textile S.C	37.2	887	8.59	37.2	115.75	15	ND	4.33	2.18
	Mahavier Textile Plc	32	920	6.95	144	44.16	25	12.89	24	12
	Jiadong Textile plc	29	1210	7.03	89.62	714	23.33	2.83	ND	1.04
2017	Meta Abo Brewery S.c	23	1320	8.3	240	90	ND	1.71	17.32	5.47
	Balezaf Alcohol and Liquors	28	876	4	4880	14928	860	17.8	151.41	11.1
	Sabata Agroindustry	25	1560	6.46	300	711.2	770	10.48	18.72	3.63
	Hafede Tannery	31	1780	4.7	1024	2517.33	135	49.79	565.08	4.1
	Ayka Addis Textile and Investment Group	34	1320	6.5	42.24	157.92	10	0.53	13.64	2.4
2018	Ayka Addis Textile and Investment Group	21	1200	7.31	173.64	352.8	290	39.06	58.59	1.91

NB: ND means not detected.

3.1.2. Electrical conductivity (EC)

The EC ranged between 1200 and 1870 µs/cm (Table 2) and these values are above the permissible limit endorsed by WHO (2010) for all industries except Arbamich textile, Mahiber textile, and alcohol and liquors factory. The highest concentration of EC was detected in tannery and agroindustry in the area (Table 2).

3.1.3. BOD and COD

The highest BOD concentration was recorded in alcohol and liquor, and tannery industries (Table 2). BOD ranged between 37.2 and 4880 mg/L (Table 2) and these values were above the permissible limit set by WHO in all industries. The BOD values were greater than 12 and 15 mg/L suggesting the occurrence of pollution of Grade F, which implies bad water conditions as per the standard recommendation by UK GQA BOD category. The COD ranged between 90 and 14928 mg/L was surpassed the permissible limit set by WHO (1996) of 80 mg/L in all industries and thus implies grossly polluted of >80 mg/L (Table 2). Thus, high concentration of BOD and COD were detected in alcohol and liquors, and tannery factories in the area.

3.1.4. TSS and ammonia

The TSS values were between 135 and 860 mg/L (Table 2) which was above the permissible limits recommendation by WHO (50 mg/L) for alcohol and liquors factory, Agro-industry, textile, and tannery industries (Table 2). The TSS values of alcohol and liquors, and agro-industry depict that the grossly polluted status of water condition compared to the standard set by WHO (2004) (>278 mg/L).

3.1.5. Ammonia, Total Phosphorus (TP), and Total Nitrogen (TN)

The TP values (Table 2) ranged between 1.91 and 12 mg/L (Table 2) and these were above the permissible limit of BIS (1.0 mg/L) in the textile, brewery, alcohol and liquors, agroindustry, and tannery industries. The TP concentration was also categorized based on standard set by UNIDO (2019) as oligotrophic (<5 mg/L), mesotrophic (5–25 mg/L), eutrophication level (28.5–30 mg/L), eutrophic (25–250 mg/L) and hypertrophic (>250 mg/L) and thus, brewery, alcohol and liquor factories were categorized in the mesotrophic. The TN concentration value was within standard set by WHO in all industries except Ayka textile, tannery, and alcohol and liquors factory. The ammonia value was also above the permissible limit recommendation by WHO (2010) (1.5 mg/L) in all industries. In sum, the proportion of concentration of the EC, COD, BOD, and TN in industries were estimated to be 53%, 32%, 9%, and 2%, respectively.

3.2. Analysis of physicochemical properties of industrial wastes (2019)

3.2.1. Temperature and pH

The results of the analysis of physicochemical parameters of wastes discharged from factories during the field survey (2019) were presented in Table 3. The water temperature of samples ranged between 18 and 30.8 °C (Table 3) which was above the maximum permissible limit set by UNIDO (15 °C), CCME (15 °C), and WB (15 °C).

The pH value ranged between 4.5 and 4.7 log units (Table 3) which was recorded in alcohols and liquors factory, tannery during dry season and alcohols and liquors during both seasons (Table 3). The low pH values were recorded in the tannery and alcohols and liquors factory depicting the acidity of discharged effluents in the area. Similarly, the pH values recorded were above permissible limit of WHO (2010) (6.5–8.5 log units). Specifically, the low pH concentration value was recorded in tannery and alcohol and liquors factory.

3.2.2. Electrical conductivity, EC

The EC value ranged between 2389 and 10450 µs/cm (Table 3) which was above the permissible limit in all sample sites except for the upper stream (Table 3) of FDRE EPA (2003) (1000 µs/cm). For instance, the EC value of tannery during the dry season was 10,470.05 µs/cm at 25 °C. Specifically, the highest EC concentration value was recorded in tannery (10470 mg/L in wet and 10450 mg/L in dry), textile (5710 mg/L in wet) and brewery in dry (5423 mg/L) and wet (5450 mg/L) season in 2019 (Table 3).

3.2.3. BOD and COD

The BOD values ranged between 20 and 460 mg/L (Table 3) and these are above the permissible limit of WHO (<6 mg/L) (Table 3). The highest physicochemical concentration value was recorded for COD and BOD in the area. The high concentration COD value was recorded in the tannery and alcohol and liquors industry in the dry and wet season. The highest concentration value of BOD was recorded in tannery and alcohol and liquors factories. Generally, the physicochemical properties were decreasing in order of EC > COD > BOD > TN > ammonia > temperature > pH (Table 3).

3.3. Results of spatial and seasonal variation of physicochemical properties in the Sabata River

The physicochemical parameters of water samples from different locations along the Sabata River were analyzed during the wet and dry seasons. Samples from the upper stream of the Sabata River had low values for the physicochemical parameters estimated.

3.4. Temperature, pH, and EC

The water temperature was above the standard limit (see Table 4) of UNIDO (15 °C), CCME (15 °C), and WB (15 °C) in the upper stream, middle stream, and lower stream in wet and level of the Sabata river dry season (Table 4). However, pH value was within standard limit set by WHO (7–8.5) log units in the Sabata river. However, the pH value was not within standard limit set by WHO (2004) (6–9) log unit in

Table 3. Results of physicochemical properties of effluents from industries (2019).

Seasons	Sampling sites	Temper ature, ^{0}C	EC, µs/cm	pH	BOD, mg/L	COD, mg/L	TSS, mg/L	Ammonia,mg/L	TN, mg/L	TP, mg/L
Wet	Ayka Addis Textile	30	5700	7.8	35	33	41.3	28	34	0.5
	Meta Abo Brewery	18	5400	4.5	270	150	132.3	68	83	11.5
	Alcohol and Liquors	25	2389	4.5	ND	2380	143.3	60	70	2.2
	Hafde Tannery	21	10450	7.5	460	4970	621.5	670	810	30.2
	Agro-industry	30.1	5489	7.7	45	37	34.2	28	23	0.4
	Upper stream	22	603	7.4	20	24	21.3	10	13	0.0001
	Downstream	28	5360	6.5	253	310	176.3	240	290	1.4
Dry	Ayka Addis Textile	30.8	5710	7.9	38	58	44	4.5	33	0.0001
	Meta Abo Brewery	23.8	5450	8.6	148	271	148	30.5	250	11.6
	Alcohol and Liquors	26	2390	4.7	ND	2900	228	2	25	1.4
	Hafde Tannery	21.9	10470	4.95	464	5450	725	51	460	3.1
	Agro-industry	30.7	5490	7.7	46	55	47	6	36	0.0001
	Upper stream	22.5	604	7.5	22	27	34	3.5	10	0.0001
	Downstream	29	5410	7	256	1025	248	2	38	1.4
Range	Ayka Addis Textile	30–30.8	5700–5710	7.8–7.9	35–38	33–38	41.3–44	4.5–28	33–34	0.5–0.0001
	Meta Abo Brewery	18–23.8	5400–5450	4.5–8.6	148–270	150–271	132.3–148	30.5–68	83–250	11.5–11.6
	Alcohol and Liquors	25–26	2389–2390	4.5–4.7	ND	2380–2900	143.3–228	2–60	25–70	1.4–2.2
	Hafde Tannery	21–21.9	10450–10470	4.95–7.5	460–464	4970–5450	621.5–725	51–670	460–810	3.1–30.2
	Agro-industry	30.1–30.7	5489–5490	7.7	45–46	37–55	34.2–47	6–28	23–36	0.4–0.0001
	Upper stream	22–22.5	603–604	7.4–7.5	20–22	24–27	21.3–34	3.5–10	10–13	0.0001
	Downstream	28–29	5360–5410	6.5–7	253–256	310–1025	176.3–248	2–240	38–290	1.4
Mean	Ayka Addis Textile	30.4	5705.0	7.85	36.5	35.5	42.65	16.25	33.5	0.25
	Meta Abo Brewery	20.9	5425.0	6.55	209	210.5	140.15	49.25	166.5	11.55
	Alcohol and Liquors	25.5	2389.5	4.6	ND	2640	185.65	31	47.5	1.8
	Hafde Tannery	21.45	10460.0	6.23	462	5210	673.25	360.5	635	16.65
	Agro-industry	30.4	5489.5	7.7	45.5	46	40.6	17	29.5	0.20
	Upper stream	22.25	603.5	7.45	21	25.5	27.65	6.75	11.5	0.0001
	Downstream	28.5	5385	6.75	254.5	667.5	132.15	121	164	1.4

Table 4. Results of physicochemical properties of water in Sabata River.

Season	site	Temp., O_c	EC, µs/cm	pH	TSS mg/L	BOD, in mg/L	COD, mg/L	Ammonia-N, mg/L	TN, mg/L	TP, mg/L
Wet	R1	23.4	167.8	7.7	48.0	54.0	234.0	2.2	0	0.37
Wet	R2	20.9	286.0	7.7	548.0	1350.0	12345.0	3.28	2.3	1.44
Wet	R3	20.3	1003.0	4.9	678.0	4895.0	13459.0	16.28	4.3	5.2
Dry	R1	20.9	192.4	7.7	43.0	57.0	245.0	3.36	0	0.49
Dry	R2	18.3	499.0	7.3	867.0	1460.0	12432.0	5.28	6.4	6.65
Dry	R3	20.3	2126.0	7.9	889.0	5467.0	14545.0	17.64	5.8	6.19
Range	R1	20.9–23.4	167.8–192.4	7.7	43.0–48.0	54.0–57.0	234.0–245.0	2.2–3.36	0	0.37–0.49
	R2	18.3–20.3	286.0–499.0	7.3–7.7	548.0–867.0	1350.0–1460.0	12345.0–12432.0	3.28–5.28	2.3–6.4	1.44–6.65
	R3	20.3	1003.0–2126.0	4.9–7.9	678.0–889.0	4895.0–5467.0	13459.0–14545.0	16.28–17.64	4.3–5.8	5.2–6.19
Mean	R1	22.5	180.1	7.7	45.5	55.5	244.0	2.78	0	0.43
	R2	19.3	372.5	7.5	707.5	1405.0	12388.5	4.28	4.4	4.05
	R3	20.3	1564.5	6.4	783.5	5181	14002.0	16.96	5.1	5.69

N.B: R1-upperstream, R2 -middle stream, R3-Downstram.

downstream in the wet season (4.9 log unit). The EC value was above safe limit recommended by WHO 2010 (500 µs/cm) in the Sabata river.

3.5. BOD and COD

The BOD values (see Table 4) were higher than the permissible limit set by WHO (2004) >12 mg/L in all parts of Sabata River (Table 4). Based on UK GQA grade and values for BOD, the Sabata River was recorded BOD value above 15 mg/L of BOD that make this river categorized in grade F and bad water quality status. The COD value was above standard limit endorsed by WHO (2004) 10–80 mg/L in the Sabata river in the downstream (14,545 and 13,459 mg/L), and middle stream (12,345 and 12,432 mg/L) in dry and wet season respectively that indicate grossly polluted as WHO (2004) (>80 mg/L).

3.6. TSS and ammonia

The TSS values (see Table 4) were higher than the recommended limit set by ISI (500 mg/L), and WHO (200–350 mg/L) in the downstream in dry and wet and middle stream dry and wet season of Sabata river (Table 4). Ammonia value was above standard limit for quality water set by WHO (2010) (1.5 mg/L) in the dry and wet season in the area.

Generally, the physicochemical properties of Sabata river was not significant ($p > 0.05$) for pH, temperature, and EC in all part of the river, TSS highly significant ($p > 0.05$) in lower and middle stream, ammonia very highly significant ($p > 0.05$) in downstream, and BOD highly significant ($p > 0.05$) in the downstream and middle stream. Furthermore, high concentration value of physiochemical properties was observed in COD followed by BOD, EC, TSS, temperature, and pH in that order during both seasons in the study area. The temperature, pH, BOD, COD, TSS, Ammonia, and EC in downstream was above permissible limit for river water endorsed by WHO in Sabata river of Ethiopia. Similarly, the high concentration values of physicochemical properties were recorded in COD, BOD, and EC in the downstream and middle stream of the Sabata river. This indicates the need to safeguard the river water from untreated effluents discharge from industries in the area.

Furthermore, physiochemical properties were statistically very highly significant ($p > 0.05$) in temperature, BOD, COD, EC, TSS, TN, and TP in the treatment group (textile, brewery, agroindustry, alcohol and liquors, and tannery industries) in 2019 (Table 5).

4. Discussion

The amount of wastes discharged from manufacturing industries in the Sabata area has not been estimated. However, the factories have released chemical wastes, heavy metals, and others into water bodies or open fields. The present study on the physicochemical parameters of the Sabata River showed that a high concentration values of COD, BOD, and EC in the downstream and in the area. Similarly, most operating industries in Ethiopia have not waste treatment plants, discharge their untreated effluent to the adjoining rivers, not properly functioning treatment plants, sources of problem to the environment and the neighboring communities (Tsegai Berhane, 2015). Likewise, the COD and BOD in the middle and downstream parts of Kechene-Kurtumie-Bantiyketu and Kebena River of Addis Ababa city showed varied concentrations due to natural purification capacity and dilution of river water (AARDP, 2017). EC in Kechene-Kurtumie-Bantiyketu and Kebena rivers of Addis Ababa City were above WHO permissible limit due to the presence of much-dissolved cations and anions in the river (Ibid). Clarke (1994) study conform to the present study that physicochemical properties of river water disruption were caused by anthropogenic activities such as increasing population, urbanization, and industrialization that resulted in declining ecosystem services.

The temperature (tannery, textile and agroindustry), pH (tannery and alcohols and liquors), BOD (tannery, alcohols and liquors), COD (textile, brewery, and agroindustry), TSS (all industries except upper stream, Arbamich textile, Mahiber textile, and alcohol and liquors factory) and EC (downstream of Sabata river) were above permissible limit recommended by WHO in Sabata industry area. The studies on effluents from the paint industry of Nigeria was conform with the present study implying ineffective in reducing the TSS, BOD, and COD to acceptable limits (Aniyikaiye et al., 2019). Similarly, the concentrations of BOD, COD, TSS and pH levels were above the permissible limit recommendation by FDRE EPA in Dukem town textile industrial effluents area of Ethiopia (Diriba et al., 2017). Furthermore, the physicochemical of pH, EC, TDS, TSS, and COD of effluents from paint industries in Addis Ababa were above the permissible limit set by ES and WHO (Berihun and Solomon, 2017).

The temperature, pH, BOD, COD, TSS, Ammonia, and EC in downstream was above permissible limit for river water endorsed by WHO in Sabata river of Ethiopia. Similarly, the temperature, pH, conductivity, BOD_5, and ammonia were beyond permissible limit of WHO for river water (Tamiru Sisay, 2015). Similarly, the physicochemical water quality of Lake Victoria was negatively affected by industrial wastes with high values of BOD (Seth, 2015). Also, higher levels of temperature, EC, and low pH were reported due to increased solubility of ions in the area (Seth, 2015). Likewise, Awash river was categorized as poor and marginal, and poor and fair water quality in the upper basin and middle/lower basin respectively (Keraga et al., 2017). However, low pH does not mean low impact rather higher toxic acid component with an adverse effect on water quality in the area. Mekonnen (2007) study was also conform with the present study with the BOD level above the permissible limit of industrial waste loads in Akaki Kality and Eastern Akaki River. This study was complying with the physicochemical properties study of the Sabata River. Other studies on physicochemical levels of the Bisnit river of Ethiopia reported similar results to our observation (Tamiru Sisay, 2015). On the contrary, temperature and pH was within the permissible limit at downstream of both Modjo and Akaki rivers (Abrha, 2015) and Kechene-Kurtumie-Bantiyketu and Kebena rivers (AARDP, 2017).

The pH, temperature, and EC were not significant in all parts the of Sabata river. The TSS, Ammonia and BOD were highly significant in lower and middle stream, very highly significant in downstream, and highly significant in the downstream and middle stream of the Sabata river, respectively. On the contrary, the pH was highly significant in wet season in Victoria Lake (Seth, 2015). Similarly, the BOD was highly significant in Victoria Lake (Seth, 2015).

The TP concentration value was higher in tannery in the Sabata area. The TP concentration value was the standard limit of eutrophic (FDRE EPA, 2003) in the tannery (2019), mesotrophic in brewery (2019) and oligotrophic levels in the rest of industries in Sabata town. This might be

Table 5. ANOVA results as function of industrial wastewater, 2019.

Parameters	Group	Mean ± SD	Pr (>0.05)
Temperature	Control	3.61 ± 3.6100	0.0002303 ***
	Treatment	215.88 ± 30.8396	1.348e-08 ***
pH	control	0.0315 ± 0.0315	0.8142
	treatment	23.5852 ± 3.3693	0.0130 *
Ec μs/cm	Control	900 ± 900	0.04159 *
	Treatment	114936676 ± 16419525	<2e-16 ***
BOD, mg/L	Control	600 ± 600	0.4607
	Treatment	324480 ± 46354	2.327e-05 ***
COD, mg/L	Control	273006 ± 273006	0.03071 *
	Treatment	47237062 ± 6748152	2.31e-07 ***
TSS, mg/L	Control	42 ± 42	0.004678 **
	Treatment	708382 ± 101197	1.467e-15 ***
TN mg/L	Control	3335 ± 3335	0.540885
	Treatment	475932 ± 67990	0.005855 **
TP mg/L	Control	0.81 ± 0.810	0.06714
	Treatment	1453.60 ± 207.657	3.086e-10 ***

* (statistically significant); ** (statistically highly significant); *** (statistically very highly significant).

due to runoff mixed up the agricultural farm fertilizer with industrial wastes in the area. However, The present study was also consistent with the TP concentration value in the stream of Bisinit of Gondar of Ethiopia eutrophic level (FDRE EPA, 2003; Tamiru Sisay, 2015). Similarly, the phosphate was above the permissible limit except at the source in Kechene-Kurtumie-Bantiyketu and Kebena rivers (AARDP, 2017).

Generally, the high concentration value of physiochemical properties was observed in COD followed by BOD, EC, TSS, temperature, and pH in that order during both seasons in the study area. Moreover, the high concentration values of physicochemical properties were recorded in COD, BOD, and EC in the downstream and middle stream of the Sabata river. This indicates the need to safeguard the river water from untreated effluents discharge from industries in the area. Similarly, the concentrations of BOD, COD, TSS and pH levels were above the permissible discharge limit of Ethiopia EPA in Dukem town textile industrial effluents and thereby, the local environment, people, and their livestock highly exposed to contaminated industrial effluents (Diriba et al., 2017). Thus, a large number of these industries of tannery, alcohol, soap, brewery, plastic factories, and other factories situated in Sabata town, however, they release their effluents into rivers without any treatment that might be a point source of environmental pollution that affect human and animal health.

5. Conclusion

This study investigated the concentration level of the physicochemical properties of effluents from industries signaling environmental pollution in the area. The physicochemical properties concentration value was evaluated against the international standard for water quality in the area. The level of BOD, COD, and TSS were above the standard endorsed by WHO and implying pollution of the water in the area. A similar trend was observed in effluents from all factories studied during the years 2016–2019. The pH concentration value of the effluents from alcohol and liquors and tannery factories (2017) were beyond the permissible limit. Furthermore, the level physicochemical properties such as temperature, BOD, COD, EC, TSS, TN, and TP depicted statistically significant in all industries during 2019 except upper stream. This indicates the adverse impact of industrial effluents on the water quality in the area.

The result of this study depicted that the EC, BOD, COD, and pH value were above the standard set by WHO along the studied Sabata River. This portrayed the water quality of Sabata river was adversely disrupted and thereby, not suitable for drinking, farming, and industrial uses. The TSS, ammonia, and BOD were also quite significant in the downstream and middle stream of the River. These industrial wastes often discharge either untreated or only partially treated wastes openly into the environment, and affecting the local community health, livestock, wetland, and vegetable farms.

Furthermore, Ethiopia has not implemented maximum permissible safe limit for concentration of physicochemical of industry wastewater release into water bodies (rivers or streams) and others. Effluents from such industries were not managed in the systematic way using waste treatment technologies. This may result in a high concentration of physicochemical that may disrupt the environment. To tackle the adverse impact of the industrial wastes, an integrated and area specific approach of industrial waste management were required for industries waste management. Thus, the government should take this into account and devise mitigation strategies through enforcing existing standard of industrial pollution control regulation, installation of treatment plant, transforming of industrial residual into biogas products, awareness creation for the society, initiation of sustainable corporate industrial responsibility, and the implementation of environmental protection regulation.

Declarations

Author contribution statement

Fekede Terefe Gemeda: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Dawit Diriba Guta, Feyera Senbeta Wakjira, Girma Gebresenbet: Conceived and designed the experiments.

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Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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