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Research Article

Analysis of the level of Selected Environmental Pollutants in the Effluent Discharges of Tana Flora Floriculture Industry, Amhara Region, Ethiopia ”

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ABSTRACT

Floriculture is one of the fast growing sectors in Ethiopia generating income for individuals and the government. However, the industry uses many pesticides and chemicals which damage the environment. Tana flora floriculture found in Lake Tana watershed, Amhara Region, Ethiopia discharges wastes to the environment, affecting the aquatic ecosystem of the lake. So, the current study was aimed to evaluate the level of water quality parameters of effluents discharged from the floriculture. 36 samples were collected from four sampling sites. The collected samples were subjected to the analysis of six water quality physicochemical parameters and four trace metals. The pH, EC, To, PO4-3, NO3-1 and BOD5 of the samples from the impaired sites were found to be in the range 3.91 to 6.52, 592 to 4680 µS/cm, 20.20 to 25.00 0C, 55.3 to 410.6 mg/l, 35 to 76.4 mg/l and 53.03 to 104.4 mg/l, respectively. The respective values were found to be 6.97,183µS/cm,23.5 0C, 7.37 mg/l, 26.7 mg/l, 33.26 mg/l for the reference sites. The Cu, Zn and Mn content of the impaired sites were found to be in the range 0.31 to 0.74 mg/l, 0.13 to 0.79 mg/l and 0.01 to 0.02 mg/l. Significant differences($p<0.05$) were observed between the samples from the reference and impaired sites. Levels of the physicochemical parameters and trace metal contents of the effluent discharges were found to be higher than the samples from the reference sites. This indicates the pollution load of the industry on the environment.

Key Words: Floriculture, effluent, physicochemical parameters, trace metals, Tana Flora.

HIGHLIGHTS

The work presents:

The level of water quality physicochemical parameters of effluents discharged from Tana

Flora Floriculture industry;

Heavy metal and anion contents of the effluent discharges were exhaustively investigated

ANOVA statistical analysis was conducted to evaluate the differe nce among the effluentdischarges from different sites and the samples from the reference site [1,2].

The results showed that the level of the water quality parameters were found to be above the permissible levels, and the floriculture industry has negatively affected both humans and the environment in the study area.

INTRODUCTION

Industrialization is obligatory to a nation’s socio-economic development as well as its politicalstature in this globalized world, as the global economy is led by free market (Gudeta, 2012). Industries vary according to process technology, size, nature of products, characteristics and completely of waste discharges (Amuda et al., 2006). Accordingly, rapid industrial development and becoming an element of having a power of a

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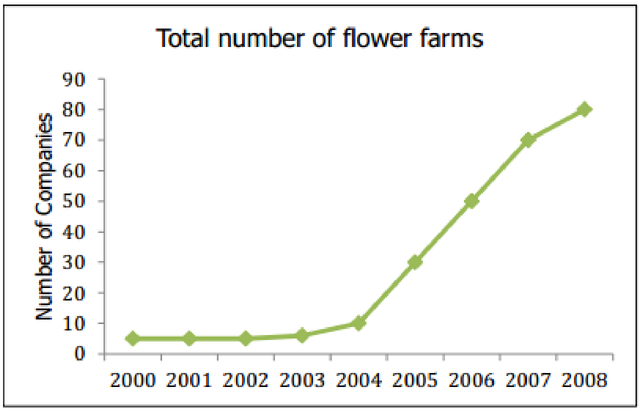
continent and the world seems the vision of most country, but this shouldn't be at the expense of the environment. Environmental poisoning chemicals released from different industries and penetrate into the soil, plant and finally enter into the food chain is one of the current focus area of researchers (Ashworth and Alloway, 2003). Floriculture is defined as "The segment of horticulture concerned with commercial production, marketing, and sale of bedding plants, cut flowers, potted flowering plants, foliage plants, flower arrangements, and noncommercial home gardening." Even though the floriculture expansion has an impact on the environment, it continues to advance since the period when started. It is a profitable agri-business throughout the world. The demand for the luxurious products has increased in the international market in recent years. The international market for flowers reached $40 billion at the end of 2008 (Getu, 2009) [3-7].

The Ethiopian Floriculture sector began in 1997 with just two flower farms (Meskel Flower and Ethio-flora), but has grown to more than 81 operational flower farms in the country (Figure 1).

Figure1: Number of flower farms in Ethiopia (Tamrat, 2011).



The rapid growth of the industry is due to a variety of factors such as a mild climate, government support, proximity to the global market, ease of transportation, favorable investment laws and incentives, and abundant and cheap labor (Getu, 2009; Gebreeyesus & Iizuka, 2010). According to Fikadu (2019), Ethiopia exports more than 80 million stems per month to 40 countries,70 % of which go to the Netherlands. The level of production has made Ethiopia the second largest producer of roses in Africa next to Kenya and sixth in the world after the Netherlands, Colombia, Ecuador, Kenya and Israel (Table 1).

Table1: Top Flower Supplier Countries to the EU in 2010 (ITC, 2012b)

Country	Amount of Stems Supplied	Value in Thousand Euro	Rank in Value
Kenya	2,647,893	275,927	1
Ethiopia	1,029,342	103,972	2
Ecuador	274,936	92,668	3
Colombia	83,441	27,564	4
Uganda	271,612	22,661	5
Zambia	190,442	16,829	6
Zimbabwe	305,961	11,212	7
Tanzania	60,559	6,424	8
India	21,853	2,303	9
Brazil	2,615	221	10

The sector's contribution to create job opportunity and export revenue has been progressively increased over the last few years. According to the information obtained from Ethiopian Flower Producer Association (EFPA, 2007), 35,000 to 50,000 workers are employed; of which 60% are women. The floriculture industry contributes the largest share of the Ethiopian economy by setting better investment and export enhancing policy which improves to 100 million USD second biggest in 2007, increase of five-fold from 2005. In 2008, Ethiopia has earned 186 million USD from horticulture exports out of which 80% was generated by flower (Getu, 2009) [8-11].

However, there are many problems in floriculture industry which needs solutions to continue the development of the sector with rapid speed. One of the problems in floriculture industry is un sustainability of market acceptability of flower industries. As it grows on such a large scale, there are concerns about potential environmental impacts such as water pollution from fertilizer and pesticide use. According to Ministry of Agriculture and Rural Development (MoARD, 2007), Crop Protection Department's Quarantine Office, Ethiopian floriculture industry use more than 300 chemicals as pesticides, insecticides, fungicides and nematocides and growth regulators. These too much chemicals kill useful organisms in the soil and disturb the biodiversity (Gizaw et al., 2007). The floriculture industry consumes large volumes of water which causes decrement of both surface and underground volume of water. According to Fliess et al., (2007), the global flower industry has received some negative publicity because labor unions, environmental activists and other NGOs have raised a number of issues linked to conditions of production on developing country flower farms. Inappropriate choice of cultivation methods and a wide range of use of chemicals and fertilizers realized for damage large areas of land and water (Fliess et al., 2007). For instance, Greenwood Flower found in Hawassa, Ethiopia, uses 80,000 liters per day/ha: indicating utilization of 2.4 million liters of water in a month (personal communication) [12-16].

Companies such as Rose Ethiopia and Garad Flowers are some examples causing shrinkage of water (Aklilu,2008; Trade and Industry Minister, 2006). Getu (2009) stated that intensive chemical fertilizers and pesticides frequently applied to produce a quality rose affects the environment . The negative effect of pesticide application includes influences on water and soil quality, effect on non-targeted lives like soil organisms, aquatic life, human beings, insects, cattle etc., air pollution and increase of pesticide resistance by targeted pests (Mulugeta, 2009).

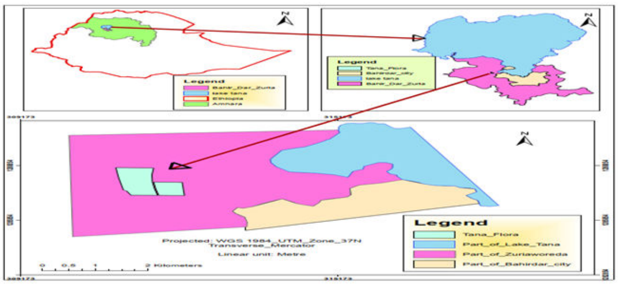
Environmentalists are also concerned that effluent materials are damaging the environment, get into the soil, into water bodies used by people and cause serious damage (Tilahun, 2013). In Amhara Region, Ethiopia, Floriculture industries are expanding with ever increasing negative impacts on the environment. Tana flora is one of the floriculture industries found in Bahir Dar Zuria district, Lake Tana watershed, Amhara Region, Ethiopia. Effluents discharged from this floriculture are exposed to runoff and ground water movement. A large proportion of liquid wastes are disposed off to the groundwater and the environment without any controlling mechanisms. This broadly affects the soil, surface and ground water body and thereby the aquatic ecosystem of the lake. Although the influences have been occurred for many years, there is no quantified information about the influence of the effluents discharged from the Floriculture. Ther efore, the current study was conducted to evaluate the level of se lected water quality physicochemical parameters and some trace metals in the effluents discharged from the floriculture [17-22].

MATERIALS AND METHODS

Description of the study area

Tana Flora is located at Wonjeta Kebele, Bahir Dar Zuria district, Amhara Region, Ethiopia, geographically located at 11°35'30" North latitude and 37°23'30" East longitude (Figure 2). It was established on 22th June 2009 by Gafat Endowment and Tis Isat Water Works. It is 582 kilometers far from Addis Ababa and 18 kilometers from Bahir Dar. The area receives an average annual rainfall of 800 to 1200 mm (MoA, 2012). According to the reports given between 1960 to 2006, the annual maximum temperatures of the area varied from 25 to 28°C and its minimum temperatures ranged from 7.9 to 13.4°C. In betwe en 1961 and 2009, the annual precipitation of the area declined approximately by 163 mm (Legesse et al., 2013). A vast expanse of land in the study area has fertile soils, which are related to their geological formation and basaltic parent material. However, there is an indication that soil acidity is becoming a major problem due to excessive leaching of soluble salts. The area is characterized by well drained and reddish lateritic soils (Tana flora laboratory result, 2009). Currently, the area has 124 hectares of land of which 40 hectare is allocated for the greenhouse production of fresh cut roses for the world flower market. The floriculture has created job opportunity for 950 people of which 70% are females. It contributes for the country economic growth from export of cut flower and its average annual income has reached 10 million USD. On the other hand, the effluent discharged from the floriculture has an impact on the environment [23,24].

Figure2: Location map of the study area.



Description of the sampling sites

Four sampling sites were selected purposively. 36 samples (12 samples for three rounds) were collected in November to December, 2018 (no rain dilution factor) from the effluents discharged from the floriculture. The reference samples were taken from the reservoir that collects clean water from Lake Tana. All samples were collected in fresh, clean polyethylene bottle containers, labeled with numbers, place and date of collection. The samples were then stored at ambient temperature until they were analyzed [25-28].

Sampling site S0 (reservoir)

This site is located within the floriculture industry near to the greenhouse where cut flowers are packed and arranged for transportation (Fig 3). It is used to collect water from Lake Tana supplied by water delivery pipes, and ground water used for irrigation to the flower farm and preservation of cut flowers. In addition, the reservoir also collects rain water from the roof of green houses during winter time. According to the information obtained from this Floriculture industry, 85% of water used in the floriculture is gained from Lake Tana and the remaining 15% is from ground water. Infiltration of water in to the ground is protected by plastic sheet. The reservoir supply water to the farm in the form of drip irrigation.

Sampling site S1 (septic tank)

This site is located out of the greenhouse where the wastewater discharged after the process is collected. It collects wastewater from packing green houses, rain water from roof of green houses and release to the final temporary storage tank. Although the collecting tank is not covered with concerts or any other materials, it is covered with green grasses, dried tree leaves, cut flower residuals and plastic sheets. This makes the waste water to be always under the shade (Figure 3).

Sampling site S2 (temporary open land storage)

This is the site which collects discharges from the rooms where fertilizers and chemical are mixed. The chemical rooms and the containers used for mixing of fertilizers and chemicals are washed daily. The canal is not cemented or covered properly with plastic sheets. So, hazardous wastes washed off from the chemical rooms and containers infiltrates in to the ground and flows to the open land (Figure 3).

Sampling site S3 (open land)

The site is found near to the rooms where fertilizers and chemicals are mixed and discharged into the farm for irrigation purposes. The waste discharged into the open land has great chance to infiltrate and mix with the ground and becomes the cause of ground water pollution. Although there are small septic tanks near to the mixing rooms, they are all filled with mu d and other materials, cannot discharge the waste properly [29].

Figure3: Images showing the sampling sites (Own survey, November, 2018)

Equipment and Reagents

pH meter (JENWAY model 370), EC meter (HANNA model Hi9033 multi range conductivity meter), BOD5 (APHA 1998), hotplate, volumetric flask (100,150 ml), filter paper (what man no.1), Spectrophotometer (ModelDR 7100, Japan), Dropper (LDPE 0.5-1 ml), sample cells (1-inch square, 10 ml), Palintest Nitra test Tube (PT526, 20ml), palintest photo meter and AAS (Analytik Jena AGGLE, Berlin, Germany) were the equipments used in the research.

BDH chemicals (Ltd-UK), Nitric acid (NHO_3 (69-72%), Hydrogen peroxide (30 %), hydrochloric acid (37%) La $(NO_3)_2$, calcium chloride (anhydrous), Palintest phosphate, HR tablets, SR tablets, Deionized water (in 2% HNO_3), H_2SO_4(98 %), ferric chloride (hexa hydrated), KI(acidified) were among the analytical grade chemicals used in the research. Solutions of Cu, Zn, and Mn were prepared in the laboratory [30-32].

Sample analysis procedure

In-Situ Measurement

The measurement of physicochemical parameters such as water t emperature, electrical conductivity and pH were carried out directly at the sampling sites. Water temperature was measured using temperature analyzer probe by dipping in water for about 2 to 4 minutes. Likewise, electrical conductivity and pH were determin ed using portable conductivity meter and pH meter, respectively.

Laboratory analysis

Trace metal analysis

The concentration of heavy metals (Cu, Zn and Mn) in the effluent and water samples were determined using AAS. Standards used in establishing the analytical curve for the trace metal determination were prepared from stock solutions (1000 mg/l). The intermediate solution (10 mg/l) of each metal was freshly prepared from the stock solution in 100 ml volumetric flask through dilution with de-ionized water. Finally, working standards of metal solutions were prepared from the intermediate solution in 250 ml volumetric flask. Calibration curves were determined by running three-point calibration standards at specified wavelength and slit width of the analytics of copper, zinc and manganese (324.8 nm, 0.7 nm), (219.9 nm, 0.7 nm) and (279.5 nm, 0.2 nm), respectively, as described by Maiti (2004). After calibrating the instrument, the sample solutions were aspired in to the AAS and the concentration of the metals were determined.

SODIUM (NA)

To determine the sodium concentration of the effluent and water samples, the instrument was standardized with known concentration of sodium ion, in the range of 1 to 100 mg/l. The samples having higher concentration were diluted with distilled water and the dilution factor was applied to the observed values. 5 ml of the water sample was added into the test tube followed by the addition of 0.11% of cesium chloride. The solution was mixed properly and the concentration of Na was determined using readings from AAS at a wave length of 589.0 nm.

ANION ANALYSIS

NITRATE (NO3-)

The Nitra palintest method was used to determine the nitrate content of the effluents. In this method, the nitrate was first reduced to nitrite and the resulting nitrite was then determined by a diazonium reaction. The reduction stage was carried out using the unique Zinc- based Nitra test Powder and Nitra test Tablet. Nitra test Tube graduated sample container with hopper bottom was used to facilitate settlement and decantation of the sample. The nitrite was determined by reaction with sulphanilic acid in the presence of N-(1-naphthyl) ethylene diamine. The intensity of the color produced in the test was proportional to the Nitrate concentration and was measured using a Palintest Photometer.

Phosphate (PO43-)

The phosphate (HR) palintest was done based on the vanadomolybdate method. The distinct advantage of the palintest method is that all reagents required can be provided in the form of a tablet. The test was carried out simply by adding a single tablet to a sample of boiled water. A supplementary tablet may be optionally used for the removal of silica interference. The reaction of the phosphate with ammonium molybdate, in the presence of ammonium vanadate, formed the yellow phosphovanado molybdate. The intensity of the color produced was proportional to the phosphate concentration and was measured using a palintest photometer.

Biochemical oxygen demand (BOD5), Azide titration method

In the BOD5 test, wastewater samples were collected in specialized BOD bottles designed to allow full filling with no air space and provided an airtight seal. The bottles were filled with various amounts of the wastewater sample to reflect different dilutions. Two BOD bottles were filled with distilled water (blank) without air bubbles. The sample was neutralized to pH 6.5 using dilute NaOH and H_2SO_4. Finally, the BOD level was quantified by titration using 0.025 N of sodium thio-sulfate until the straw yellow color was decolorized.

DATA COLLECTION FROM FOCUS GROUP DISCUSSION (FGD) AND KEY INFORMANTS

FGD and Key informant interview were conducted with the surrounding dweller community.. FGD is a rapid assessment, semi structured data gathering method in which a purposively selected set of participants were gathered to discuss issues and concerns based on a list of key themes drawn by the researcher (USAID, 2011b). Key informant interview was accomplished through a qualitative indepth inter view with people who know what is going on the environment d ue to Tana flora floriculture industry. Semi structured questionn aires were prepared for key informants to collect information on the impacts of the floriculture on human health, water bodies, air, soil, crop and animal production. In addition, focus group discussion and key informants were used to get information about waste disposal mechanism, environmental im pact assessment, and types of chemicals and fertilizers used. The purpose was to collect further information from community lea ders, professionals, residents, the floriculture experts and workers who have firsthand knowledge about the floriculture and its effect on the environment. These survey data were used to triangulate the levels of environmental pollutants found in the laboratory analyses with their effects to environment .

DATA MANAGEMENT AND STATISTICAL ANALYSIS

The data collected was examined and checked for completeness and clarity. Numerical data collected using interview schedules was coded and entered in the computer and analyzed using appropriate computer packages. Results of interviews were critically assessed in terms of each response and examined in accordance with the objectives of the study and thereafter presented in narrative excerpts within the report. The results of all experiments were expressed as mean ± SD of triplicate measurements. Water quality data were analyzed by MS Excel 2007 and SPSS (statistical package for social science). One way ANOVA using SPSS software version 22 followed by Tukey's post hoc multiple comparisons test was used to check the statistical differences in the water quality parameters among the samples from different sampling sites.

RESULTS AND DISCUSSIONS

PHYSICOCHEMICAL PARAMETERS OF THE ANALYZED WATER SAMPLES

Table 2 :Physicochemical parameters of the analyzed water samples

Sampling sites	pH	EC(µs/cm)	Temperature(°C)	PO43- (mg/l)	NO3- (mg/l)	BOD5(mg/l)
S0	6.97 ± 0.01a	183 ± 0.67d	23.5 ± 0.28b	7.37 ± 10c	26.7 ± 1.5b	33.3 ± 15.13b
S1	6.52 ± 0.10ab	592 ± 60c	20.20 ± 0.4d	82.5 ± 12b	35 ± 3.0b	104.4 ± 5.80a
S2	5.43 ± 1.80c	2069 ± 167.7b	25.00 ± 0.62a	55.3 ± 0.78b	57.5 ± 5b	53.03 ± 7.93b
S3	3.91 ± 1.50d	4680 ± 40a	22.43 ± 0.68c	410.6 ± 35.4a	76.4 ± 33.6a	63.9 ± 5.80b
P-value	0.001	p≤0.01	p≤0.01	p≤0.01	0.29	0.02
WHO(2008)	6.5-8.5	500-750	<40	5	50	2.0-5.0
EPA(2003)	6-9	100-1000	-	≤0.005-0.1	1-10	<5
FAO(1950)	6.0-8.5	3000	-	2	50	8

Values with different superscripts down the column are significantly different (P < 0.05).

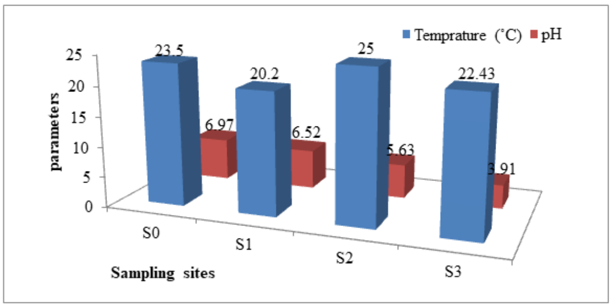
PH

The average pH values of samples from the current study area were in the range of 3.91 ± 1.5 to 6.97 ± 0.1. The pH values of the samples from S2 and S3 were found to be below the permissible levels of WHO (6.5-8.5) and FAO(6-9) while the samples from S0 and S1 were found to be in the acceptable range of the WHO and FAO (Table 2). The low pH values of the samples from S2 and S3 might be due to the addition of nitrate and sulfur containing fertilizers and chemicals which in turn react with water, and leads the formation of nitric acid and sulfuric acid. These low pH value may affect the physiology of organisms (Kaoga etal., 2013 and it may cause an increase in toxicity of heavy metals (Ka vitha et al., 2012). The ANOVA result revealed statistically signif icant differences (P<0.05) of pH values of the samples from different sampling sites.

TEMPERATURE

Water temperature is one of the controlling factors for dynamics of aquatic environment. It interferes in the organisms' metabolism, influencing the reproduction, accelerating the reactions and increasing the degradation rate of organic matter. The present investigation showed that the temperature of the effluent and water varied from 20.20 ± 0.4 to 25.00 ± 0.62°C. This is different from the reports by Tamiru and Leta (2017) (19 to 23.3°C), and Okweye (2013) (19.01 to 23.93°C). Significant differences were observed between samples from the impaired and reference sites. The low water temperature for site one might be because of the shading effect as the site is covered with green grasses, dried tree leaves, cut flower residuals and plastic sheets. The measured values were found to be below the maximum permissible limit of WHO. This revealed that the water temperature of the study sites was likely suitable for aquatic lives. The water temperature of the analyzed samples with their respective pH values is depicted in figure 4.

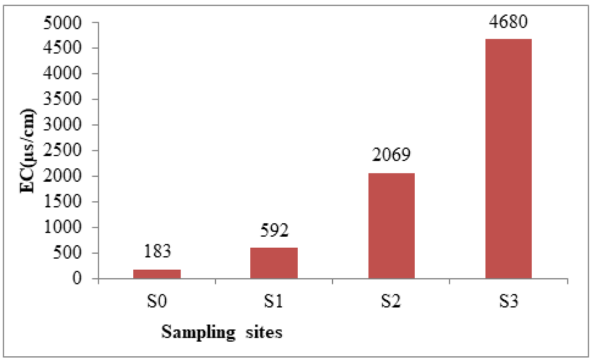
Figure4: pH and temperature values of the analyzed water samples



ELECTRICAL CONDUCTIVITY

The EC of the analyzed water samples ranged from 183 ± 0.67 (S0) to 4680 ± 40 µS/cm (S3) (figure 5). The EC values of the samples from S2 and S3 were found to be higher than the permissible levels of WHO and EPA whereas samples from S0 and S2 were found to have EC values of lower than the maximum permissible levels of WHO and EPA. Previously conducted studies in Wedecha river reported an EC values in the range of 351 to1882.7 µS/cm, which exhibited EC values above the permissible level of WHO and EPA. The highest electrical conductivity of the samples from S3 might be associated with the effluents discharged from fertilizer and chemical mixing rooms. Abbasi (2000), and Harper and Mavuti (2004) reported that fertilizers and pesticides, which bring point discharge of the floriculture industries, might contribute to the elevated electrical conductivity. The lower EC values of S0 and S2 were feasible with the nature of the samples as the sa mples from these sites didn't contain the effluents directly disch arged from fertilizer and chemical mixing rooms. Significant diff erences(P≤0.05) were observed between the samples from the reference and impaired sampling sites. This might be because of the difference in the concentration of different ions as the conductivity of water is a function of the number of charged ions in a solution. This indicated that the amount of dissolved ions responsible for the conductivity were not the same in the four sites due to their difference in the potential sources of water pollution. According to Abbasi (2000), the salinity hazard is low if EC is less than 0.75 µs/cm, and conductivity of pure water at 25°C is 0.055 µS/cm. Based on EPA (2003), the optimum EC for stream water is 100 - 1000 µS/cm at 20°C. Based on these standards, the current study revealed that the water quality is very low as the EC values of the analyzed samples is very high.

Figure 5: EC level in the analyzed water samples of the sampling sites.



BIOLOGICAL OXYGEN DEMAND (BOD5)

Biological Oxygen Demand (BOD) is an indicator of oxygenation status of water bodies, the demand of oxygen resulting from organisms in water that take oxidizable organic matter (Harper et al., 2003). The BOD5 of the analyzed water samples varied from 33.26 ± 15.13 (S0) to 104.4 ± 5.8 mg/l (S1) (figure 5). There were significant differences (P≤0.05) between the reference and impaired sampling sites. The BOD5 values were found to be above the permissible levels of WHO (2.0-5.0 mg/l), EPA (< 5 mg/l), and FAO (8 mg/l). Mostly, unpolluted streams have a BOD5 that ranges from 1 to 8 mg/l (USEPA, 1976). According to EPA (2003), the optimum BOD5 for stream water is ≤5 mg/l. So, the results of the current study revealed the presence of high biological oxygen demand or high organic load indicating the area is under the influence of the floriculture industry. This might be due to remains of solid wastes like flower leaves, wood, cut of grasses and leaves from shading of tress found in the sampling sites that might increase organic matter.

PHOSPHATE (PO43-)

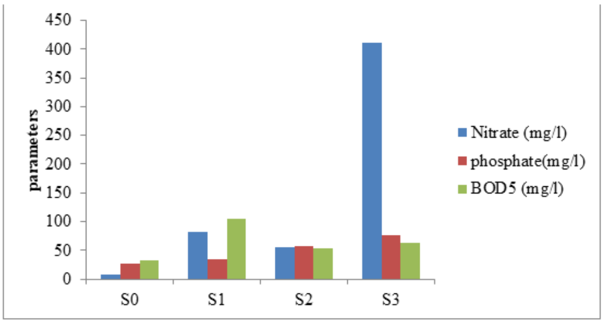
Phosphate determination is useful in measuring the water quality since it is an important plant nutrient and a limiting factor among all other essential plant nutrients. The concentration of phosphate in the study area varied from 7.37 ± 1.4 (S0) to 410.6 ± 35 mg/l (S3) (figure 6). Statistically significant differences (P≤0.05) were observed in phosphate concentration between the reference and impaired sites. The phosphate concentration of all samples were found to be higher than the permissible levels of WHO (5 mg/l), EPA (≤ 0.005-0.1mg/l) and FAO (2 mg/l). Tamiru and Letain (2017) reported the maximum phosphate concentration of 19.6 mg/l for the study conducted in Wedecha river of

Debrezeit. In the current study area,large amount waste water is discharged from chemical mixing rooms every day. Therefore, th e highest phosphate concentration of the current water samples might be due to the discharge of effluents from fertilizers and chemicals mixing rooms.

NITRATE (NO3-)

The concentration of nitrate in this study ranged from 26.7 ± 1.5 (S0) to76.4 ± 33.6 (S3) mg/l (Figure 6). The nitrate content of all samples were found to be above the maximum recommended value of EPA (10 mg/l). Although there were no significant difference between the reference and the two impaired sites, there was an increment in the nitrate concentration of the impaired sites as compared to the amount from the reference site. This might be due to the nitrate emitted from nitrogen containing fertilizers. According to EPA (2003), the nitrate content exceeding 10 mg/l in drinking water becomes toxic to human beings. Hence, the amount of nitrate in this study was very high, and it may lead to the depletion of dissolved oxygen in the area which in turn affects the biomass and species diversity of aquatic organisms.

Figure6: The variation of Phosphate, Nitrate and BOD5 levels in the analyzed water samples of the sampling sites



Trace metals analysis

Table3: Concentration of selected trace metals in the analyzed water samples of the sampling sites

Sampling sites	Cu (mg/l)	Zn (mg/l)	Mn (mg/l)	Na (mg/l)
S0	1.19 ± 0.12 a	1.22 ± 1.27 a	0.20 ±2.80 a	99.7 ± 6.70 b
S1	0.74 ± 0.14 b	0.79 ± 0.70 ab	0.02 ± 0.00 b	119.4 ± 3.40 a
S2	0.63 ± 0.15 b	0.13 ± 0.07 b	0.01 ± 0.00 c	15.0 ± 2.00 d
S3	0.31 ± 0.03 c	0.19 ± 0.05 b	0.01 ± 0.00 d	23.5 ± 1.30 c
P- value	p≤0.01	0.054	p≤0.01	p≤0.01
WHO (2008)	2.00	3.00	0.50	200
EPA (2003)	2.00	-	-	-
FAO (1995)	0.20	2.00	0.20	-

Values with different superscripts down the column are significantly different (P < 0.05).

COPPER

Although Cu is an essential trace metal, it can be toxic to plants and algae when its concentration is above the permissible level. It also causes an undesirable taste to water. The concentration of copper in the analyzed water sample of the studied area ranged from 0.31 ± 0.03 (S3) to 1.19 ± 0.12 mg/l (S0) (Table 3). Although the concentrations of copper for all sampling sites were above the permissible level of FAO (0.2 mg/l), it was still below the maximum recommended limits of WHO (2mg/l), and EPA (2 mg/l). There was significant difference between the reference and impaired sites. This might be due to precipitation of copper in the impaired sites. Despite slightly numerical variations, the results of the current research were in agreement with the reports by Attah and Regasa (2013) (0.37 ± 0.002 mg/l), who conducted a research on a floriculture industry found in Holeta, Wolmera district, Ethiopia.

ZINC

Zinc is one of the most important trace metals that plays a vital role in the physiological and metabolic process of many organisms. It is an important trace element for animals, bacteria and plants including human being. It is also used for protein synthesis and is a metal which shows low level in surface water due to its restricted mobility from weathering of rocks and any other natural source. The measured concentration of Zn in the studied area was in the range from 0.13 ± 0.07 (S2) to 1.23 ± 1.23 (S0) (Table 3). The highest concentration of Zn in S0 might be due to the natural deposition of Zn containing compounds, and the formation of some insoluble salts discharged from the fertilizer and chemical mixing rooms might be the cause for relatively low concentration of zinc for the remaining sampling sites. The concentration of zinc, for all sampling sites, were below the maximum recommended level of WHO (3 mg/l) and FAO (2 mg/l). Therefore, the water is not toxic to plants and human beings in this level of zinc concentration. There were significant differences between the reference and impaired sites.

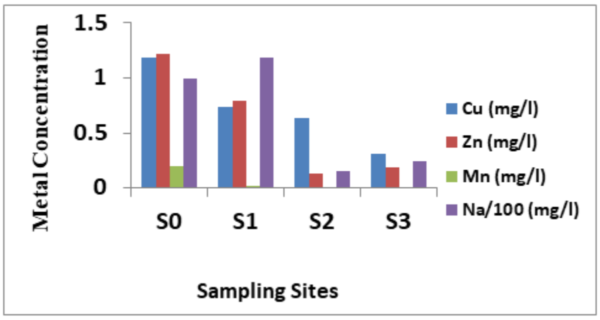
MANGANESE

The Mn concentration of the study sites ranged from 0.01± 0.00 (S3) to 0.20 ± 0.18 mg/l (S0) (Table 3). The concentration of manganese for all sampling sites was found to be below the maximum recommended limit of WHO (0.5 mg/l) and FAO (0.2 mg/l). In the other study, conducted in the floriculture industry around Holeta, Wolmera district Ethiopia, the measured value of Mn was found in the range 0.13 ± 0.01 to 0.82 ± 0.03 mg/l, which is relatively higher than the Mn concentration of the current study. This implies the current floriculture didn't emit potential amount of Mn; hence, in this range of Mn concentration, it cannot be the potential source of plants and animals health problem.

SODIUM

Too high concentration of sodium can be a factor for blood pressure. The concentration of sodium for the analyzed water samples ranged from 15.0 ± 2.0 (S2) to 119.4 to ± 3.4 mg/l (S1) (Table 3). The highest concentration of sodium at S1 might be due to the detergents like Burkina utilized in the floriculture to preserve the flower till packing and distributing to the market. The concentration of sodium for all sampling sites were below the permissible level of WHO (200 mg/l). Significant differences were observed in sodium concentration among the selected sites. Tadesse et al.(2018) reported higher sodium concentration of 8.8 ± 1.2 to 1557.6 ± 7.6 mg/l, for the research conducted in Rebu river. The graphical representation of the amount of trace metals found in the samples is summarized in figure 7.

Figure7: Variation of concentration of trace metals in the water samples of the sampling sites



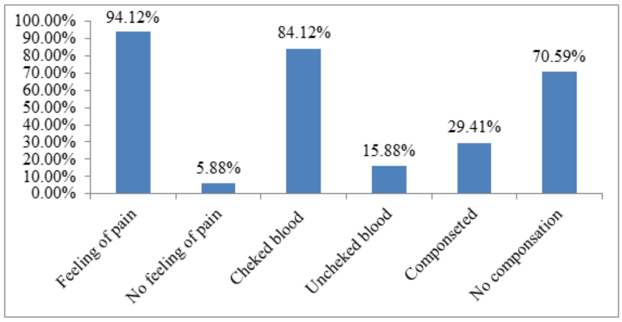
Qualitative Results obtained from key informants and focus group discussion

The impact of the floriculture on human health:

The length of time that workers stay on their work is not the same. Although the labour proclamation limits the maximum working hours (LP, 2003), the survey data shows that about 79.59 percent of farm employees work 8 hours a day during the normal season whereas 29.41% percent regularly work between 10 to 14 hours per day. Those who irrigate flowers and spray chemicals normally start to work late in the afternoon around 3:00 pm and leave late in the night. This latter group does not get shift differentials for working at night. Due to the exposures for chemicals, many employees in the flower farm have different feelings of pain. The feelings of the respondents in the current study is enclosed in figure 8. Based on the results obtained, 94.12% of the respondents said that before adapting the bad smell of the chemicals, they were vomiting, and headache was sometimes visible. They stated that the feelings of pain depends on the section in which they are working and the length of working time. In addition to health risks caused by working in a standing position for long hours, lack of transportation or escort services in the evening shift is what concerned many women. Some women disclosed the prevalence of sexual harassment and abuse that younger women encounter when going home at night, and expressed their grief over a higher rate of unwanted pregnancies and abortions among women working in flower farms.

Almost all respondents said that the flower farm do not give first aid services for incidences, and the personal protection material such as gloves, goggles and others were not delivered to the workers except for those who were working in chemical mixing rooms. 15.88% of the respondents stated that the workers in the chemical spraying section were more exposed to chemicals, and the industry tried to check up their blood toxicity levels every 3-5 months. Based on the survey result, 84.12% of the respondents stated that their blood toxicity levels were not checked; when they were infected by chemicals, they were shifted to other non-chemical working sections. According to the survey result,70.59% of the respondents stated that expenses for medical treatments were covered by themselves. In order to solve different social and economic issues, the farm communities and workers have established a labor union. However, the union was very week and it couldn't solve the social and economic issues of the workers.

Figure 8: Levels of feelings of pain, blood toxicity checkup and expense compensation of the workers in Tana Flora Floriculture



Solid and Liquid wastes of the floriculture:

The survey result (100 % of the respondents) revealed that solid wastes including plastics, cartons, unwanted leaf, stem and chemical containers were not properly managed; simply they were disposed in the open land. Rarely, some solid wastes were used for compost preparation and others like plastic sheets were collected for selling purpose.

The survey result indicated that liquid wastes discharged from chemical and fertilizer mixing rooms were disposed in to the ground and the open land without any pretreatment, as stated by 88.24% and 11.76% of the respondents, respectively. During rainy seasons, large amount of waste was getting into Eneferanzeriver and Lake Tana by runoff causing the pollution of the aquatic environments.

The waste water released from the floriculture had green color and bad smell. This was due to the chemicals and fertilizers used in the floriculture. According to the survey result, 82.36 % of the respondents compared the drinking water and the water released from the floriculture, and they have realized the taste and color differences. Nevertheless, 17.64% of the respondents couldn't identify the taste and color differences. Based on the information obtained from the respondents, fishes have been living in the reservoir since eight years ago, but their body size didn't show any increment. This might be due to the effect of the toxic chemicals discharged from the green house and chemical mixing rooms as the rooms are located near to the reservoir.

The survey result (52.94% of the respondents) indicated that the liquid wastes have negative impacts on crops, plants, animals and grazing land. They stated that crops grown near to the floriculture showed stunted growth and couldn't bear fruits. They also stated that due to negative impact of the wastes released from the floriculture, honey bees couldn't prepare enough amount of honey and honey production has decreased from 30 to 5 kg per hive in the last five years. On the contrary, 11.76% of them said that liquid wastes have no negative impacts, and the remaining 35.29% of the respondents couldn't understand or realize the impacts of the liquid waste.

THE IMPACT OF THE FLORICULTURE ON SOIL AND AIR POLLUTION

One of the current issues that attracts many researchers' attention is the chemicals in the wastewater discharged from the industries and directly enter in to the soil, plant and lastly into the food chain (Ashworth and Alloway, 2003). Lado et al. (2005) conducted a research on irrigation with effluents in relation to physical parameters such as seal formation, infiltration and soil loss. They showed that the chemical wastes contained in the effluents reduced the infiltration rate significantly, and affected the rate of seal formation and dissolved organic matter. According to the information obtained from the survey, wastes emitted from the floriculture lead to the change in the soil physical properties such as soil color. Wastes discharged from the floriculture enter in to the soil so that the soil develops salinity.

In this study, the researcher tried to communicate with the local community to hear their feelings about the smell of chemicals, and the resident community stated that they are highly affected by the bad smell of the chemicals discharged from the floriculture. Tilahun (2013) stated that the bad smell of the chemicals is very toxic to asthmatic people and fish. According to Getu (2009), pesticides have the ability to contaminate air, water, soil and its organisms. Due to the extreme volatility nature of chemicals, it is estimated that only 0.1% of the total applied pesticide achieve its goal and the remaining 99.9% of the chemical found in the air as pollutant. The pesticides sprayed in the greenhouses travel an average distance of 1,500 miles, significantly increasing global warming and air pollution (Farkas, 2006). Based on the Proclamation number (295/2002), the floriculture industry has prepared EIA document by environmentalists and related experts. But no monitoring and evaluation activities were done on the implementation of the document and hence the environment was highly affected by wastes from the floriculture.

THE IMPACT OF THE FLORICULTURE ON LAND USE LAND COVER

Floriculture industry needs large area of land; this large area of land requirement become the cause of land cover change and conversion of important ecological area. Before the establishment of the Tana Flora floriculture, the land for the current floriculture was owned by farmers; it was covered with indigenous trees and used for cultivation. According to the local farmers information, the floriculture industry caused shortage of grazing and farm lands for the local community. They stated that more than 84 hectares of land owned by the floriculture investors has not been used for production for the last 4-5 years. This is an indicator of the impact of the floriculture to cause shortage of land for the local community which directly affects their livelihoods. They were stressing that because of most of the agricultural lands and eucalyptus plantations were changed from forest cover and farmlands to floriculture farms. The study examined perceptions held by local people, and their reactions to the flower industry; on the basis that failure to restore livelihoods could lead to conflict. Therefore, there has been a shortage of agricultural products and forest products. Many scholars such as Abbink (2007), Kabra (2009), Korn (1986) and Cernea and Mathur (2008) reported the impact of unplanned land dispossession which usually causes landlessness, joblessness, marginalization, food insecurity and loss of livelihoods and, thus, leads to extreme poverty. According to Fatuma (2008), most of the local communities and land holders perceived and explained the issue of land use change in association with the shortages of agricultural products, fuel, and construction woods and price increase as well as the rapid climatic change seen in the locality. Similar reports were documented by the ILO (2006) which stated that one of the side effects of floriculture expansion in Ethiopia is a problem of conserving the forest resources.

CONCLUSION

The study was conducted to evaluate the level of selected water q uality physicochemical parameters and some trace metals in the effluents discharged from Tana Flora floriculture Industry. The study indicated that the electrical conductivity, the PO_4^{3-} content, NO_3^- content and BOD_5 levels of the analyzed effluent samples were found to be above the permissible level of the WHO, EPA and FAO standards while the concentration of trace metals were found to be lower than the maximum recommended values. The values of the phys icochemical parameters and the concentration of trace metals of the samples from the impaired sites were found to be higher as compared to the samples from the reference sites. The survey results revealed that solid and liquid wastes released from the floriculture were discharged in to the environment without any pretreatments causing intensive problems on humans, animals, plants and other environmental components such as soil, water and air. Although the floriculture industry has prepared EIA document, no monitoring and evaluation activities were implemented and hence the environment was highly affected by wastes from the floriculture. The study also indicated that large area of land owned by the floriculture investors caused shortage of land for the local community and influenced their economic growth. Hence, the floriculture industry has negatively affected both humans and the environment. Therefore, awareness creation for the industry workers and the local community, proper management and pretreatment of wastes, and implementation of EIA document should be done so that the negative impacts of the floriculture on humans and the environment can be reduced.

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