Advances in Crop Science and Technology

Tolossa TT, Adv Crop Sci Tech 2022, 10:8

Research Article Open Acces

Brewery and Municipal Wastewater Irrigation Quality: Impacts on Selected Soil Properties around Harar City, Eastern Ethiopia

Tasisa Temesgen Tolossa*

Department of Agronomy, Haramaya University, Ethiopia

ABSTRACT

Wastewater contains a variety of chemical, physical and microbial contaminants which affect soil properties. The study was conducted at Harar city, to identify the impacts of brewery and municipal wastewater soil physico-chemical properties and irrigation water quality. Three irrigation sites were selected purposively and sites were categorized into three groups: Control (non-irrigated), brewery and municipal wastewater irrigated farmland for less than ten years ago and brewery and municipal wastewater irrigated farmland for more than ten years depending on the application of brewery and municipal wastewater and long term application. The irrigation water quality analysis showed that pH was moderately increased; BOD, COD and P concentration were above the permissible limit of FAO prescribed for wastewater irrigation quality. The results showed that bulk density was negatively decreased and moisture contents and total porosity was significantly increased. The soil EC, cadmium, lead available phosphorus, OM and CEC levels was significantly increased with the increasing of wastewater application. Mg2+ was significantly decreased by wastewater application in irrigated farmland. From the results, increase of years of application of brewery and municipal wastewater resulted in significant reduction of BD and Mg2+. The most effective way to eliminate the impact of these brewery and municipal wastewater on the soil is to develop and implement effective wastewater management plan.

Keywords: Brewery, Heavy metal; Irrigation water quality; Soil physico-chemical; Municipal Wastewater

Introduction

The reuse of industrial or municipal wastewater in agriculture is a common practice in many parts of the world. It comprises liquid wastes generated by households, industry, commercial sources, as a result of daily usage, production and consumption activities of peoples. Municipal wastewater may be a combination of some or all domestic effluent such as water from commercial establishments, industrial effluent, storm water that does not infiltrate into soil and other urban run-off. It also contains a broad spectrum of contaminants resulting from different sources [1-7].

Materials and methods

The study was conducted around Harar City, Harari National Regional State which is located in the eastern part of Ethiopia (Figure 1). The city of Harar is the capital of Harari Regional State; which is located in the East at a distance of 525 km from Addis Ababa.

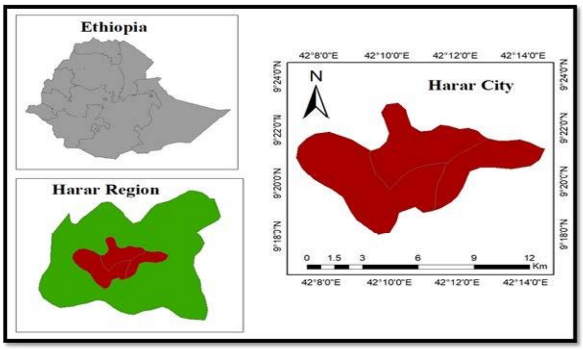

Figure 1: Map of the study area (Harar Region and Harar Town).

The selection of sampling points in the initial and final of the wastewater discharge point was systematically. A total of two wastewater samples were collected from the initial point wastewater discharge to the final irrigation site in sterilized 500 ml plastic bottles from brewery and municipal wastewater. Samples collections were conducted immediately after the factories discharge was released and joined with the sewer for urban wastewater. Then samples were collected at distance intervals of 500 m following the discharge channels. Accordingly, two samples were collected along the discharge channels and from the final discharging point. BOD bottle was used to collect BOD and COD samples. Samples were stored at optimum temperature of 20°C and made ready for physical and chemical analyses.

Prepared the samples for determination of brewery and municipal wastewater physical and chemical properties. The laboratory analysis were done at central laboratory of Haramaya University and Harar brewers Share Company laboratory at Harar.

Two kebeles (Ahumar and Sofi) were selected around Harar City for this study and three sites were selected from those kebeles. The sites were selected based on the number of years; the sites are under irrigation by using brewery and municipal wastewaters [8-10].

***Corresponding author:** Tasisa Temesgen Tolossa, Department of Agronomy, Haramaya University, Ethiopia, E-mail: tasisatemesgen@gmail.com.

Citation: Tolossa TT. (2022) Brewery and Municipal Wastewater Irrigation Quality: Impacts on Selected Soil Properties around Harar City, Eastern Ethiopia. Adv Crop Sci Tech.10:527

Received: 02-August-2022, Manuscript No. ACST-22-572; **Editor assigned:** 04-August-2022, PreQC No. ACST-22-572(PQ); **Reviewed:** 18-August-2022, QC No. ACST-22-572; **Revised:** 25-August-2022, Manuscript No. ACST-22-572(R); **Published:** 31-August-2022, **DOI:** 10.4172/2329-8863.1000527

The sample sites were categorized into three groups (0, <10, and >10) depending on the number of years they have been under irrigation by wastewater. The first group (0 control) indicates the parallel site 100 m away from the wastewater irrigated farmland from each sites which was used as a control; The second group Sofi kebele is the irrigated with wastewater for more than ten years (BMWWI>10) and the third group Ahumer kebele was farmland irrigated with brewery and municipal wastewater for less than ten years (BMWWI<10).

In this study, two stage sampling techniques was employed purposive sampling to the selected wastewater irrigation sites and followed by a random sampling designate the location of sample sites. Preliminary survey was conducted to locate sites with appropriate irrigated farmland(Figure 2).

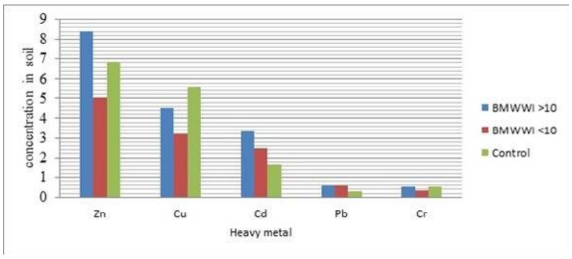

Figure 2: The concentration of heavy metal in the study sites.

The composite soil samples were air-dried, sieved to the size of 2 mm and stored in labeled plastic for measurement of total nitrogen and organic carbon the samples were sieved through 0.5 mm sieve. Sub-sample from each disturbed soil sample were prepared and made ready for physico-chemical analysis. Undisturbed soil sample was also collected at the depth of 0 cm to 20 cm using core sampler for determination of bulk density. The laboratory analyses were done at the Central Laboratory of Haramaya University.

Analysis of the soil of the study area indicated that the texture class of the soil was sandy loam for the two irrigated sites and sandy clay loam for the non-irrigated (control) farmland. This has great influence on root growth and its ability to absorb water and nutrients in quantities sufficient for optimum growth. Among other soil physical properties, soil texture was more stable, not influenced by wastewater. The highest sand content (61%) was recorded for the farmland that has been under irrigation water for less than 10 years (BMWWI<10). The lowest sand content (56%) was obtained at non irrigated area. The variation in the texture class between the irrigated and non-irrigated sites might be due to seasonal runoff discharge channel in the study sites since wastewater has no effect on soil texture [10].

Clay contents highly and significant differences with the non-irrigated and irrigated farmland. The highest clay content (26%) was recorded for non-irrigated farmland, whereas the lowest value (23%) was recorded at wastewater irrigated farmland. On the other hand, the lowest clay content was recorded at the farmland irrigated for more than ten years. The dominant soil particle in the study sites was sand followed by clay and silt. Silt content was the least at all sites.

soil reaction was slightly affected by the wastewater. In the study sites, soil reaction slightly alkaline in brewery and municipal wastewater irrigated farmland. The higher pH value (7.74) was recorded with non-irrigated (control) farmland and the lowest pH value (7.34) was recorded with irrigated farmland with brewery and municipal wastewater for less than ten years. The variation in soil pH was might be due to the presence of high content of relatively ammonium in the wastewater (Table 1), resulted in its accumulation in the soil. This suggestion was supported by the finding of, soil pH decreased with wastewater irrigation due to the oxidation of organic compounds and nitrification of ammonium. Nitrification of this ammonium would serve as a source of hydrogen ions which may lead to the decrease in the soil pH.

Descriptive statistics					
Parameters	**Initial point**	**Final point**	**Mean**	**SD (+)**	**FAO/WHO perm. limits**
pH	8.26	8.14	8.2	0.085	6.5-8.4
EC, dS/m	2.34	2.32	2.33	0.014	0.7-3.0
TDS, mg/l	945.32	762.54	853.93	129.24	450-2000
TSS, mg/l	67.98	49.65	58.82	12.96	50
DO, mg/l	0.0045	0.0003	0.002	0.002	5-6
BOD, mg/l	207.3	167	185.15	28.49	60
COD, mg/l	288	246.43	266.22	27.98	200
Na+, mg/l	44.5	33.3	38.9	7.92	200
Ca2+, mg/l	74.8	64.2	69.5	7.49	400
Mg2+, mg/l	54.3	49.6	51.95	3.32	60
K+, mg/l	66.33	51.44	58.84	10.46	<10
HCO3-, mg/l	40.5	35.3	37.9	3.676	1.5 - 8.5
CO32-, mg/l	24.5	19.4	21.95	3.606	<10
NH4-N, mg/l	14.25	7.56	10.91	4.73	-
NO¬3-N, mg/l	11.6	9.43	10.52	1.53	5-30
TN, mg/l	29.6	24.78	27.19	3.408	5-30
P, mg/l	9.43	8.64	9.04	0.56	<10

SAR	4.988	4.414	4.701	0.794	3-9
ESP %	6.538	5.538	5.763	1.096	-
Note: DO=dissolved oxygen, TDS=total dissolved solid, TSS=total suspended solid, EC=electrical conductivity, BOD=biological oxygen demand, COD=chemical oxygen demand, per.limit=permissible limits, SAR=sodium adsorption ratio and ESP=exchangeable sodium percentage.					

Table 1: Characteristics of brewery and municipal wastewater quality.

The total soluble salt contents expressed as Electrical Conductivity (EC) is an important indicator of soil health. It affects crop yields, plant nutrient availability, and activity of soil microorganisms which influence key soil processes. Electrical conductivity of the soils was significantly influenced by the wastewater. The highest electrical conductivity (0.0328 dS/m) was recorded for brewery and municipal wastewater for more than 10 years (BMWWI>10) irrigation, whereas the lowest value of EC was recorded for non-irrigated site (0.062 dS/m) Table 3. At non-irrigated and irrigated farmland difference in soil electrical conductivity there were significant at ($P<0.001$).

Measurement of the concentrations of heavy metals in the soil of the wastewater irrigated and non-irrigated farmland is in Table 3. Concentrations of Zn, Cu, Cd, Pb and Cr at BMWWI>10 (brewery and municipal wastewater irrigated land for more than 10 years) were 8.43, 4.53, 3.33, 0.57 and 0.54 mg/kg respectively. But, at non irrigated site the recorded results were 6.85, 5.6, 1.67, 0.29 and 0.54 mg/kg for Zn, Cu, Cd, Pb and Cr respectively. The concentration of Cd and Pb was significantly higher irrigated sites compared to their amount in the non-irrigated area. This might be due to release of these elements by the brewing process and their entry into the soil with the irrigation water. Based on the results of rating of Cd was above the permissible limits (0.02 mg/kg to 0.5 mg/kg) of FAO Table 3, but the result of Pb was within recommended rating (0.3 mg/kg to 10 mg/kg). High concentration of heavy metals in the soil may cause soil, ground water and health risk on human and plant in the long term. Accumulation of micronutrients and heavy metals from wastewater application could be caused directly by the wastewater composition or indirectly through increasing solubility of the indigenous insoluble soil heavy metals as a result of the chelation or acidification action of the applied wastewater.

Generally, heavy metals like, Lead (Pb), and cadmium (Cd) have no beneficial effects in humans, and there is no known homeostasis mechanism for them. They are generally considered the most toxic to humans and animals; the adverse human health effects associated with exposure to them, even at low concentrations, are diverse and include, but are not limited to neurotoxic and carcinogenic actions. The metals considered in this study include the metals which are micro-nutrient such as zinc and copper and the non-essential/toxic heavy metal which are toxic to plant when present in the soil at concentrations above tolerance level. Of the non-essential metals, Cr, Pb, and Cd, are recognized as health hazardous and all have caused major health problems as a result of environmental pollution. Compared to the concentration of other elements, the quantities of Pb and Cr are very small. But, the toxic level of these elements is reached at their low level in the soil.

The highest concentration of Zinc (Zn) was 8.45 mg Kg-1 at the site irrigated the wastewater for more than ten years. However, this concentration of Zn was not above the permitted limit of FAO Table 3 for soil, reported that continuous application of wastewater for more than 20 years had led to accumulation of heavy metals in the soil. Concentration of Zn decreases with increasing of soil pH, high organic matter contents, high level of phosphorus and with higher concentration of Cu in the soil.

Conclusions and Recommendation

Brewery and municipal wastewater application has significant impacts on physico-chemical properties of the soil. The study was undertaken in Harar City with the objectives of investigate the wastewater irrigation water quality and its impacts some selected soil physico-chemical properties in the study sites.

Wastewater showed variation between initial point and final irrigation sites. EC, COD, BOD and P concentration of brewery and municipal wastewater were higher compared to other parameters. The most effective way to reduce/eliminate the impact of these brewery and municipal wastewater on the soil is to develop and implement an effective wastewater management plan. Further investigations should be encouraged to address brewery and municipal wastewater impacts to plants and farmers. In general Harar city municipality and government should create wastewater management system, setting acceptable levels or criteria related to chemicals, rule and regulation of wastewater treatment system and recycling of wastewater should applied for sustainable use of resources and environmental protection.

Acknowledgement

None

Conflict of interest

The author declares there is no conflict of interest in publishing this article.

References

1. Sharma RK, Agrawal M, Marshall F (2007) Heavy metal contamination of soil and vegetables in suburban areas of Varansi, India. Ecotoxicology and Environmental Safety 66:258-266.
2. Rattan RK, Datta SP, Chhonkar PK, Suribabu K, Singh AK (2005) Long-term impact of irrigation with sewage effluents on heavy metal content in soils, crops and groundwater-a case study. Agric Ecosyst Environ 109:310-322.
3. Ninnekar HZ (1992) Biodegradation of environmental pollutants. Environ Biodeg. 5:149-154.
4. Walkley A, Black A (1934) An examination of degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Science (37):29-37.
5. Tatawat RK and Singh CP (2008) A Hydrochemical Profile for Assessing the Groundwater Quality of Jaipur City. Environ Monit Assess 143:337-343.
6. Mohammad Rusan MJ, Hinnawi S, Rousan L (2007) Long-term effect of wastewater irrigation of foragecrops on soil and plant quality parameters. Desalination 215:143-152.

7. Vikal P (2009) Multivariant analysis of drinking water quality parameters of lake Pichhola in Udaipur, India. Biological Forum-An International Journal 1(2):97-102.

8. Tak HI and Inam A (2010) Effects of urban wastewater on the growth, photosynthesis and yield of chickpea under different levels of nitrogen. Urban Water Journal 7(3):187-195.

9. Mbagwu JSC (1992) Improving the productivity of a degraded Ultisol in Nigera using organic and inorganic amendment. Part 2: Change in physical properties. Bioresource technology 42(3):167-175.

10. Mathan KK (1994) Studies of the influence of long-term municipal sewage effluent irrigation on soil physical properties. Bioresource Technology 48:275-276.