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Analysis of physicochemical parameters of soil samples around Bahir Dar Textile Industry, Northern Amhara, Ethiopia

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Abstract

The levels of selected physicochemical properties in the soil sample collected in Bahir Dar Textile Factory were determined by several methods. Soil samples found in the Bahir Dar textile factory were investigated for several physicochemical parameters those parameters were mainly indicator of soil properties. Results that obtained from soil samples analyzed showed that the range of the values of physicochemical properties (pH, EC(mS/cm), OM (%),OC(%), MC, CEC(cmol/kg) were 7.752-8.344, 0.130-0.214, 1.771-5.84-2, 1.027-3.389, 5.138-6.106 and 12.39-16.242 respectively. From the result of EC that generated in soil samples, soil samples that under investigated in the area of Bahir Dar textile factory were non saline and the value of pH was found vary from slightly alkaline to higher value of alkaline. Between the values of physicochemical properties as the statistical test of ANOVA there were significant differences ($p<0.05$) in the analyzed soil samples.

Keywords: Contaminated soil, physicochemical parameters, Textile Industry, Bahir Dar.

Introduction

Generally, a mixture of minerals and organic matter that can support plant life is soil and the biological active organic material, and layers of variable minerals those covers the earth's land surface indicate the soil terms[1]. Properties of the soil sample are sensitive to changes in the management and it is composed of several matters like components of mineral, organic body, living body and parts of water. As a general, soils can be contaminated by several contaminants which include agricultural and industrial pollution[2]. Contamination of soils from industrial activities or by-products is a global concern and creating a health hazard to people, livestock and plants. Characteristics of soil parameters have been used to define the quality of soil in which often with biological processes influence soil fertility in a variety of ways. Soil may be contaminated by several contaminants mainly by minerals (heavy metals) which are a globally series issue and know a time it is a serious problem[3,4]. A class of particle size possessed by soil is structure of soil which has high advantages in the soil structure of stability and developments[5].

Generally, the soil total quality and health characteristics that generalized the sustainability of agriculture and environments as well as that determine health of living things[6].

However, there was no information on levels of physicochemical characteristics of the soil in the area of Industry (Textile). It is important therefore to analyze the levels of soil's physicochemical characteristics in industry. Appropriate information obtained from this analysis will help as baseline data for the measures that should be taken to alleviate the contamination of the surrounding environment.

Experimental

Description of Sampling Area: Bahir Dar is the capital City of Amhara Regional State in which found on the southern part of Lake Tana. Bahir Dar is approximately far apart from the Addis Ababa (Northwest) which is the Capital City of Ethiopia by 565 km[7].

Table-1: The condition of the study area (source = 7).

Location	Latitude	Longitude	Elevation (m)	Annual temperature (°C)	Annual rainfall (mm)
Bahir Dar	11038"N	37010"E	1795	26	1200-1600

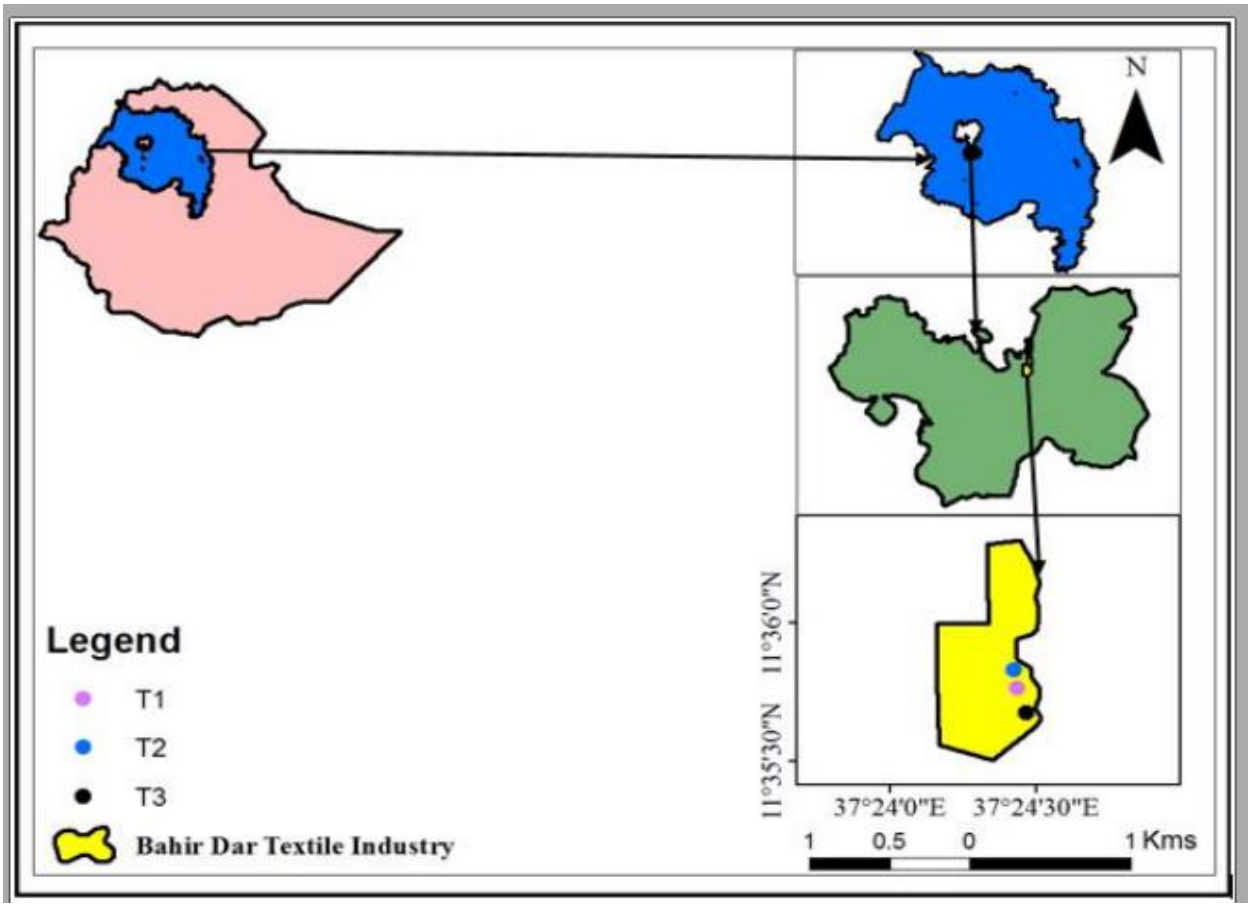

Figure-1: Location of area.

Apparatus/Instruments: The following equipments were used in this study: Polyethylene bags were used for the storage of soil samples. For the weighing of soil samples, weighing balance (Electronics) was used. Mortar, pestle and 0.5mm stainless steel sieve were used to grind and homogenize and sieve the powdered soil sample respectively. Portable of pH (CPI-Sol, ELMEIRON) device was used for determine the pH of samples. Conductivity meter (ELMEIIRON®-Grzybowice, CC-101, Poland) was used to determining the conductance of soil.

Chemical used: Deionized water was usedin the study to sample preparation, dilution, and rinsing apparatus before analysis. NaCl (99%, analytical reagents, India), NaOH, H_2SO_4 (96.0-98.0%, UNI-CHEM® Chemical reagents, India), CH_3CH_2OH and CH_3COONH_4 (97%, analytical reagents, India) were used for cation exchange capacity determination. $K_2Cr_2O_7$, H_3PO_4 and Fe $(NH_4)_2(SO4)_2.6H_2O$ (UNI-CHEM® Chemical reagents, India) were used for the determination of carbon contents and organic matter.

Sampling Procedures: Cleaning of Sampling Types of equipment: Polyethylene bags and stainless steel knife for soil sampling were properly cleaned by tap water and detergent as well as rinsed by deionized water. After that, all containers were well-rinsed with distilled water routinely and air-dried.

Soil Sampling: In the present study, all collected representative samples were carried out with in the 0-20cm depths by digging a stainless steel knife from inside the industry area. Three sub-sites were taken due to the closeness to the wastewater treatment plant, sedimentation tank of the treatment process and also to the disposal area of sludge. Three soil samples were collected near to the sedimentation tank of the treatment process (T1), wastewater treatment plant (T2) and disposal area of sludge (T3) at a distance of 150 (between T1 and T2) and 200 (between T1 and T3) meters from each other.As the general, three representative samples were systematically taken for analysis in each three sites around Industrial areas and to form composite sample, mixed together each other. The final process, 3 soil samples were obtained from three sited areas (one from each) and they were transferred into clean polyethylene containers. Soil samples were properly air-dried for 72hrs and it was grounded by the porcelain mortar and also pestle as well as stored in the clean bags for analysis.

Pre-treatments of Samples: The representative samples were first air-dried and it was sieve (0.5mm) to eliminating other impurities and representative samples were changed to the powder using pestle/mortal as well as to homogenize the sample, mixing process was carried out and this mixture was stored for further process.

Analysis of Soil Physicochemical Properties: The following physicochemical of soil sample was analyzed.

pH: The concentration of hydrogen ion is determined by pH and the acidity and basicity are determined by it. In beaker which contains 10g of representative collected sample (soil), 100mL deionized H_2O was transfer for the 1:10 suspension and this solution was stirred continuously in a shaker for 30 min and the representative sample was allowed to settle and measurement of pH was carried out by using supernatant. The pH was measured in the suspension at 25 ± 1ºC using glass electrode pH meter (CPI-Sol, ELMEIRON).

Electric Conductivity (mS/cm): The soil EC was analyzed by the EC meter. In the clean dry beaker which contains 10g of representative air-dried samples, pour/transfer carefully 100mL of H_2O to this container. By using a glass rod, the solution was stirred for 10 min and 30 minutes the solution was allowed to stand. Finally, the solution's electric conductivity was immediately determined by immersing the conducto-meter (ELMEIRON® Zabrze-Grzybowice, CC-101, Poland) after the solution was settling slowly.

Contents of Organic Materials (OC&OM) (%): In general**,** level of OC in representative samples was analyzed in using a chromic acid in the method of wet digestion using the diphenylamine indicator. In the first step, representative air-dried sample of 0.5 in gram was weighted and transfer to dry cleaning 0.5L volumetric flasks, immediately 10 and 20mL of 1.0N $K_2Cr_2O_7$ and concentrated solution of H_2SO_4 were added to this mixture with the pipette and burette respectively followed by swirled. Then, it was swirled slowly up to the mixture were mixed for 1 min. For thirteen min on the asbestos sheet, the reaction was allowed to proceed to minimized/avoid the burning of the table. Before titration of the sample, Orthophosphoric acid (concentrated) of 10mL was added and before titration carrying out, a ferroin indicator of a 1mL was transferred into the volumetric flask which contains digested solution. Finally, brownish-red color was formed from the yellowish followed by greenish color when the excess potassium dichromate titrated by FAS (0.5N) which indicate the endpoint of titration[8]. The following formula was used to calculate the organic carbon as:

$$\text{OC (\%)} = \frac{(B-S)\times N \times 0.39 \times \text{mcf}}{\text{wt.of soil(oven dry)}} \quad (1)$$

Where, B=mL of the standard that used to neutralized potassium dichromate (1N $K_2Cr_2O_7$) i.e. blank reading. OC = Organic Carbon, S = mL of standard which used to titrate of soil sample and, N = Normality of FAS with 0.5N), As 1000cc (N) $K_2Cr_2O_7$ = 3.0g C, 1cc (N) $K_2Cr_2O_7$ = 3g C / 1000 = 0.003g C.

The percentage of organic matter that oxidized is only 77% and its fraction (100/77) = 1.31.

The organic carbon found in the soil organic matter is 58% and when the OC is multiplied by the fraction of 100/58 (1.724) that gives the OM in percentage.

$$\text{OM (\%)} = \%\text{OC in soil} \times 1.724 \quad (2)$$

Moisture Contents (%): In the present study, the level of moisture in the representative soil was analyzed using oven-dried methods in which carried out by transferring representative composite sample (0.5g) to evaporating dish. At 105ºC, the given representative sample was dried in one day using oven-dried in which to achievea constant weight, the sample weight was taken. The water content, that found in the soil sample corresponding to the weight that loss[9]. In each of soil sample, the MC was calculated by the following formula (%):-

$$\text{MC in soil sample (\%)} = \left(\frac{\text{Weight lost in drying part(g)}}{\text{Weight of sample (Initial) (g)}}\right) x\ 100 \quad (3)$$

Levels of moisture in representative sample can be calculated as follow:

$$\text{Moisture correction factor (mcf)} = \frac{100 + \%\ \text{moisture}}{100} \quad (4)$$

Cation Exchange Capacity (%): The cation exchange capacity of representative soil per 100g expressed in milliequivalent and which is the number of cations that neutralized the negative charge is measured. In the clean beaker (500mL) which contains NH_4OAC of 250mL, soil sample (10g) was weighed and was shaken within the thirty min. Within two days, the given mixture was standing as well as this solution was filtrate by filter paper No. 44 in the plastic bottle. By washing of the residue repeatedly with ethanol, the excess NH_4OAC was removed. By using the NaCl solution (30mL), then washed residue was leached improved the displacement of adsorbed NH_4 1N and 250mL leachate was collected by repeating of leaching[10]. In distillation (leachate) followed by titration of the distillate (with NaOH), the displaced ammonium was determined. The CEC was then calculated as follows;

$$\text{CEC (cmol /kg) of Soil} = \frac{(VB-VS)\times N\times 100\times \text{mcf}}{S} \quad (5)$$

Where, VB = volume of the blank, VS = Sample volume, N = NaOH's normality, S = weight of sample, mcf = moisture correction factor.

Analysis of statistical: In present studies, a property of physicochemical in the representative sample was investigated by ANOVA interns of mean values with in samples. This revealed that there were a significant different ($p < 0.05$) among the sample. Software used in this study was Microsoft excel-2007 and Origin 8.1 package as well as all data were express inters of mean plus standard deviation.

Results and discussion

Analysis of Soil Sample Characteristics: Soil samples can be analyzed several parameters; some of them are listed below (Table-2).

pH: Analyzed representative pH values of oil samples was ranged within 7.752-8.344 in 3 sampling sites, which is tending towards alkaline. The recommended pH values of plant growth ranged from 6.8-8.0 and the pH values of the studied soil sample shown in Table-2 were basic as this recommendation. But there were similar pH values obtained as the present studies[11]. The pH values of analyzed representative samples was carried out for ANOVA for investigate different in between them which have different between them ($p < 0.05$).

EC of Soil Sample: The studied representative composite sample of EC values found within interval of 0.13-0.214mS/cm with their mean values of 0.161mS/cm. Electric conductivity values of the soil under 0.4mS/cm which are not considered as saline and the values of EC which above values of 0.8mS/cm are highly saline[12]. The given representative samples have not shown saline characteristics. It is much lower than the average value range from 5.03 to 6.63mS/cm given in the literature[13]. The studied representative soil sample shows statistical different ($p<0.05$) between them as ANOVA analysis.

Organic Matter and Organic Carbon: As the values of OC showed in above (Table-2), the range of OC which found in the representative samples which started in 1.027-3.389% and that of the values of organic matter ranged from 1.771-5.842%. Other studies reported that the moisture content of soil sampleless than two (<2.0%) as low; ranged between the 2.1-3.0 % as medium as and greater than the three per one (>3.1)% as high[14]. Based on this guideline, the studied soils were generally contained high average organic matter contents (3.821 %) at the point of sampling site two which have high value (5.842±0.035%) while the lowest values of the OM was recorded at the point of sampling 3. This high value of organic matter may be the presence waste of organic residues that have high organic matter. The other cases of this high value of OM can be the decomposition of plant residues which causes to building up of OM. The result obtained from this study was higher than recorded by other literature[15]. But, it is comparable with the values of other data obtained by[5]. As the ANOVA analysis, there were statistical differences ($p< 0.05$) between the organic matter as well as organic carbon in the soil sample.

Cation Exchange Capacity: The CEC in the present study soil sample ranged over from the 12.39-16.242cmol/kg while the mean values of soil sample for cation exchange capacity was 14.441cmol/kg. Around the area of a textile factory, the soil sample has a high cation exchange capacity which has lower values than the average value that was given in the other studies[16]. The statically analysis in one ANOVA variance states that cation exchange capacity of representative soil sample has statistical difference ($p< 0.05$) between them.

Levels of Moisture Soil: The representative given samples of levels of water determined by moisture contents which directly related to H_2O absorbing ability of sample (soil). The soil used in the analysis was of different moisture content varying from 5.138 to 6.106%, while in one case the MC was found to be high ranging from 35 to 57.38 as reported by other literature[17]**.** The production of gas and the sporting of microbial degradation will not increase when the moisture content was less than the value of 20% that is causes for landfill gas production[18]. According to the analysis of ANOVA, moisture contents has statistical different ($p<0.05$) between them within three sampling sites.

Conclusion

Analysis of soil physicochemical properties is mainly useful for the chemist of agriculture and the management of soil. The soil samples under the studies/investigation have different values of physicochemical properties in the different sampling points. One way analysis of variance stated that the representative samples have statistical difference ($p < 0.05$) between them in regarding to physicochemical characteristics values. This study recommends further investigations should be done on properties of other samples like plants and other edible vegetables in that area.

Table-2: Representative soil sample physicochemical characteristics (mean ± SD, n = 3).

Properties	Site 1	Site 2	Site 3
pH	8.344 ± 0.026	7.752 ± 0.085	8.025 ± 0.058
EC (mS/cm)	0.140 ± 0.002	0.214 ± 0.002	0.130 ± 0.001
MC (%)	5.138 ± 1.396	5.854 ± 0.141	6.106 ± 0.111
OM (%)	3.851 ± 0.089	5.842 ± 0.035	1.771 ± 0.032
OC (%)	2.234 ± 0.006	3.389 ± 0.020	1.027 ± 0.019
CEC (cmol/kg)	14.692 ± 0.104	16.242 ± 0.161	12.39 ± 0.106

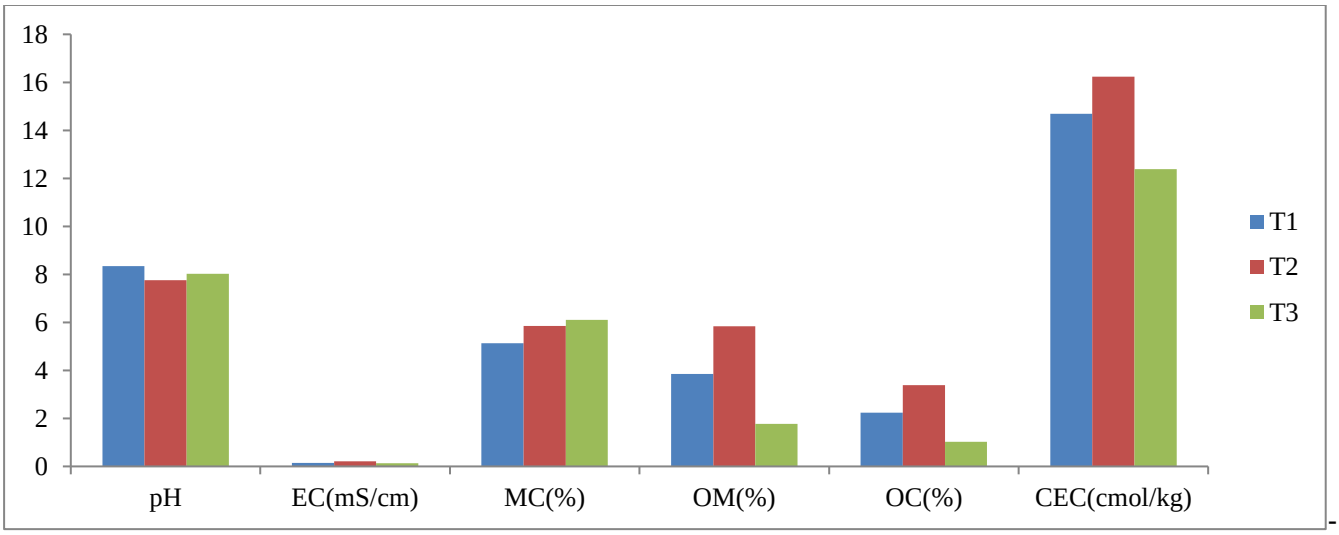

Figure-2: Mean values (mean ± SD, n = 3) of physicochemical parameters of soil samples.

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