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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 an 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.

Key words: 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 that cover the earth's land surface indicate the soil terms [1]. 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 the 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, the determine health of living things [6].

However, there was no information on levels of physicochemical characteristics of the soil in the area of Industry. It is important therefore to analyze the levels of soil's physicochemical characteristics in the 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.

MATERIALS AND METHODS

Description of Sampling Area: Bahir Dar is the capital City of Amhara Regional State in which found in 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].

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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

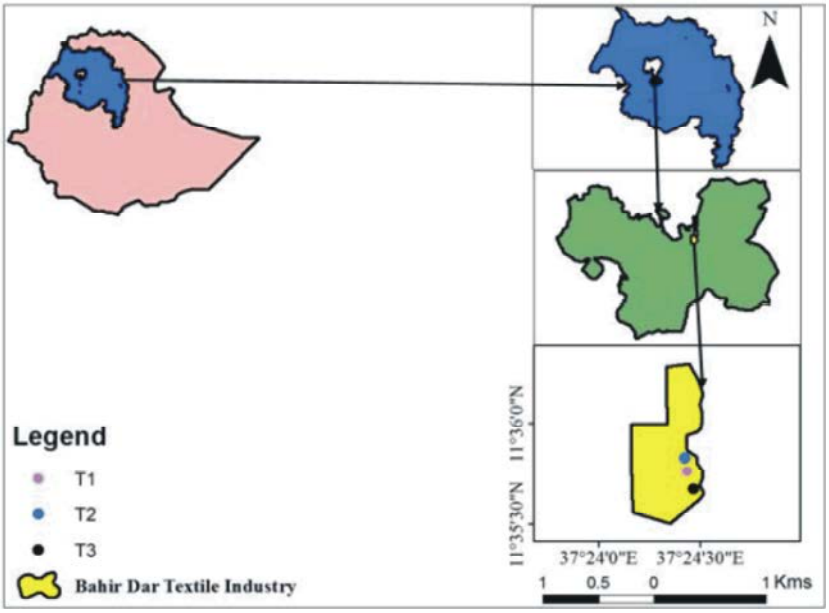

Fig. 1: Location of area

Apparatus/Instruments: Polyethylene bags were used for the storage of soil samples. For the weighing of soil samples, weighing balance (Electronics) was used. Mortar, pestle and 0.5 mm 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 to determine the pH of samples. Conductivity meter (ELMEIIRON®-Grzybowice, CC-101, POLAND) was used to determining the conductance of soil.

Chemical Used: 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: All collected representative samples were carried out within the 0-20 cm 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 (T2), sedimentation tank of the treatment process (T1) and also to the disposal area of sludge (T3). Three representative samples were systematically taken for analysis in every three sites around Industrial areas and to form composite samples, mixed. Soil samples were properly air-dried for 72 hrs 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 (0.5 mm) 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:

pH: The concentration of hydrogen ion is determined by pH and the acidity and basicity are determined by it. In the beaker which contains 10 g of representative collected sample (soil), 100 mL deionized H_2O was transferred 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 ± 1°C using glass electrode pH meter.

Electric Conductivity (mS/cm): In the clean dry beaker which contains 10 g of representative air-dried samples, pour carefully 100 mL 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 conducts meter.

Contents of Organic Materials (OC&OM) (%): The representative air-dried sample of 0.5 in gram was weighted and transfer to dry cleaning 0.5 L volumetric flasks, immediately10 and 20 mL of 1.0 N $K_2Cr_2O_7$ 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 10 mL was added and before titration carrying out, a ferroin indicator of a 1 mL 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 (0.5 N) which indicates the endpoint of titration [8]. The following formula was used to calculate the organic carbon as:

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

where, B = mL of the standard that used to neutralized potassium dichromate (1 N $K_2Cr_2O_7$) i.e. blank reading.

OC = Organic Carbon
S = mL of standard which used to titrate of soil sample and
N = Normality of FAS with 0.5 N)

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.

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

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 (0.5 g) to evaporating dish.

At 105°C, the given representative sample was dried in one day using oven-dried in which to achieve a 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 (%):

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

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

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

Cation Exchange Capacity (%): The CEC of representative soil per 100 g expressed in milliequivalent and which is the number of cations that neutralized the negative charge is measured. In the clean beaker (500 mL) which contains NH_4OAC of 250 mL, soil sample (10 g) 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 (30 mL), then washed residue was leached improved the displacement of adsorbed NH_4 1N and 250 mL 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;

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

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 within samples. This revealed that there was 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 DISCUSSIONS

Analysis of Soil Sample Characteristics

pH: Analyzed representative pH values of soil 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 were carried out for ANOVA to investigate differences between them which have differences between them ($p < 0.05$).

EC of Soil Sample: The studied representative composite sample of EC values found within the interval of 0.13-0.214 mS/cm with their mean values of 0.161 mS/cm. Electric conductivity values of the soil under 0.4 mS/cm which are not considered as saline and the values of EC which above values of 0.8 mS/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 6.63 mS/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 sample less 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 Okoro *et al.* [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.

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

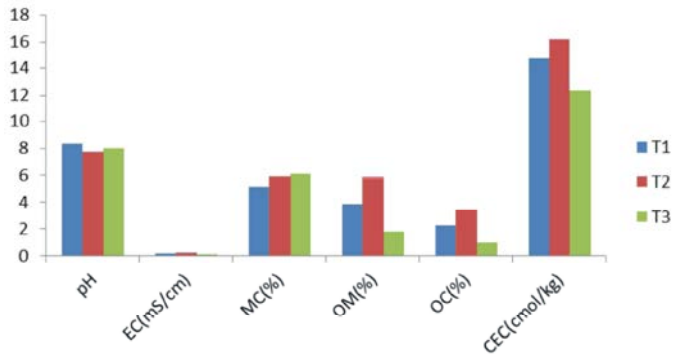

Fig. 2: Mean values (Mean ± SD, n = 3) of physicochemical parameters of soil samples

Cation Exchange Capacity: The CEC in the present study soil sample ranged over from the 12.39 – 16.242 cmol / kg while the mean values of soil sample for cation exchange capacity was 14.441 cmol / 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 the cation exchange capacity of a representative soil sample has a 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 to6.106 %, 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 have a statistical different ($p <0.05$) between them.

CONCLUSIONS

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 differences ($p < 0.05$) between them regard 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.

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