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ORIGINAL ARTICLE

Some Physico-Chemical and Bacteriological Characteristics of Soil Samples of Hail industrial Zone, Kingdom of Saudi Arabia

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ABSTRACT
The present study was undertaken for the analysis of the physic-chemical and bacteriological characteristics of soil samples collected from various sites of the industrial zone of Hail city during the period 2016-2017. This area is suspected with known long-term pollution problems. The results showed that pH values were in alkaline side, they ranged between 8.82 and 7.47. The salinity increased to the highest value at site 7 (27.07 gl-1) and site 6 (17.51gl-1). The mean total dissolved solids (TDS) was 5.5 gl-1, while the electrical conductivity (EC) ranged between less than 20 µS to more than 40 mS, with the highest value at site 7 and the lowest at sites 1 and 2. The oxidation-reduction potential (ORP) ranged between -27.7mv and -88.8mv. The bacteriological analysis indicted that the total bacterial counts mean of soil samples ranged from 5.8x108 to 2.5x106 (cfu/g). On the other hand, all soil samples were devoid of coliforms bacteria with exception to samples collected from ST.7 which contained high numbers of coliforms, faecal coliforms and E. coli. Nine bacterial genera were identified in the various soil sampling sites, however, Bacillus genera was the most dominant.
Key words: Soil contamination, physico-chemical characteristics, salinity, coliforms.

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INTRODUCTION

The functioning of the soil as a key framework and the support on its natural efficiency depends to a higher degree on the soil microflora action. That is the reason in the evaluating of anthropogenic soil contamination it is important to consider the adjustments in the size, piece and movement of the dirt microbial group [1]. There may be not yet an usually acknowledged framework for bio-indication with respect to soil contamination. Concerning illustration bioindicators would utilized pure culture microorganisms, sensitive to determined type of pollutant; the number and proportion of the fundamental taxonomic class and ecologic trophic groups of microorganisms; bacterial community tolerance; intensity of the microbiological processes – soil respiration, fixation of nitrogen, cellulose decay; soil enzyme activity and so on [2]. Soil may become contaminated with many because of an assortment of anthropogenic sources. Different possibly poisonous components, including heavy metals, might be available. Elevated concentrations of these mixes are known to influence soil microbial populations and their related exercises [3][4]. Several studies have demonstrated that microbial parameters may be useful as indicators of changing soil conditions caused by chemical pollution [5][6]. The changes in soil microbial balance can serve as an "early warning" for negative alterations in the soil conditions long before they could be distinguished by established chemical methods, furthermore in the recent past they might turn into irreversible. The complex investigations on the soil biological activity should be conducted in assessing ecological risk of soil pollutants. The reliable microbiological indicator must be established and used [7]. The natural hazard from of heavy metal pollution is pronounced in soils adjacent to large industrial complexes. It is important to investigate the functioning of soil microorganisms in ecosystems exposed to long-term contamination by heavy metals. The long-term effects of metals or other pollutants added to soil are very difficult to assess, as there are few such experiments and consequently few data [3][8]. In the Kingdom of Saudi Arabia, there is no information about the ecotoxicological effects of industrial pollutants on soil microorganisms. In this study, we analyzed soil samples from Hail industrial zone located east of the city for physicochemical and bacteriological characteristics.

MATERIALS AND MERHODS

Collection and preparation of soil samples

Soil samples were collected from 7 different sites in the industrial zone, Hail city. The soil samples in these locales may encounter serious tainting with oils, cleansers and movement conditions. In addition, a control sample from a distance away from the industrial zone (a garden soil). The choice of the inspecting destinations is mainly in view of the approach that testing must be done wherever conceivable that may guarantee high rates of polluted soils. The samples were transferred to an air-tight pre-sterilized polyethylene bag before transportation to the laboratory, numbered, and labeled with date and site of collection. When samples could not process immediately, they were stored at 4 °C for no longer than 18 to 24 h. For preparation of soil samples for analyses, the samples collected in each location were divided into two parts, one part for physico-chemical analysis while the other for bacteriological.

Physicochemical properties determination

Each sample meant for physico-chemical analysis was air dried for five days, and then sieved to ensure homogeneity using a 2mm size sieve.

The physico-chemical analysis was carried out according to methods described by Nelson and Sommers [9] and Thomas [10] at the Department Biology, Faculty of Science, University of Hail. Distilled water and sediment were mixed of one part soil to one part distilled water (1:1 by weight). The mixture was stirred for 15 seconds and then left to stand for 30 minutes before measurement. pH and oxidation reduction potential (ORP as mV) were measured using pH meter (pH 500 pH/mv/TEMP meter). Total dissolved solids (gl^{-1}), salinity (gl^{-1}), and conductivity (mS) were measured using CON 500 CON/TDS/RES/TEMP meter).

Bacteriological analyses

For bacteriological analysis of the soil samples, ten-fold serial dilutions of the soil samples were made as described by Collins and Lyne [11]; Harrigan and McCance [12]. The aerobic bacterial counts was estimated by standard spread-plate dilution method described by Seeley and VanDemarkin triplicate. Visible discrete colonies in incubated plates were counted and expressed as colony forming units per gram (cfu/g) of soil samples.

The isolates obtained were purified by repeated sub-culturing on fresh agar medium and incubated under normal condition for growth. Pure colonies isolated were inoculated on agar slants using MacConkey bottles to serve as stock cultures, incubated at 37ºC and were stored in the refrigerator at 6ºC ± 2ºC for future research.

For identification of bacteria species, the 10^{-2} dilution were placed in Bushnell Haas medium containing 15.0 g/L of agar. Inoculated plates were purified repeatedly by sub culturing. Pure culture was stored in nutrient agar slants at 4°C. The presumptive identification of bacterial species was done using morphological tests as well as biochemical tests using APi identification kits according to manufacturer's instructions.

RESULTS AND DISCUSSION

Soil and their characteristic are of great importance in an agribusines**s** economy. The pH is a standout amongst the most critical figures soil quality management. It indicates that acidity, neutrality and alkalinity of soil [13]. The amount of water, air and nutrients available for plant growth is affected by the soil physic-chemical properties and turf management practices, so determining these prameters will ultimately help to determine how to manage them effectively.

Table (1) presents the physicochemical properties of soil samples collected from the industrial zone of Hail. pH values were in alkaline side. They ranged between 8.82 and 7.47. The highest pH value was measured at the first three sites. The pH estimation of an ordinary soil can be considered as a record of its interchangeable cation saturation. Hence, the accessibility of many plant supplements relies upon the pH of the soil. The pH of soil plays a very important role in maintaining the soil fertility [14].

Table 1. pH, salinity, TDS, conductivity, and Oxidation reduction potential values at the industrial area in Hail City, KSA.

Parameter	Control	ST. 1	ST. 2	ST. 3	ST. 4	ST. 5	ST. 6	ST. 7
pH	7.64	8.52	8.51	8.17	7.82	7.8	7.47	7.81
Salinity (gl^{-1})	6.95	1.293	0.694	0.408	2.349	1.627	17.51	27.07
TDS (gl^{-1})	5.34	0.989	0.537	0.318	1.797	1.245	13.31	20.52
Conductivity (mS)	11.12	0.0198	1.071	0.627	3.632	2.495	26.19	40.1
ORP (mv)	-39.2	-88.5	-88.8	-66.4	-47.3	-46.7	-27.7	-47.3

The salinity increased to the highest value at site 7 (27.07 gl-1) and site 6 (17.51gl-1). the). the salinity of soil refers to the amount of salts in the soil and it can be estimated by measuring the electrical conductivity (ec) of an extracted soil solution. salinity can have lowest values were measured at sites 2 and 3 (st. 2 and st.3 significant impacts on agricultural production, water quality, changing the ecological health of streams and estuaries, terrestrial biodiversity and soil erosion 15]. salinity increases repair and maintenance costs for a range of services provided for public use as there is a need to replace infrastructure earlier than normal. The mean total dissolved solids (TDS) was 5.5 gl^{-1}. It's highest value was measured at site 7, while the lowest one was observed at site 3 (ST.3). TDS is a measure of the combined content all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular (colloidal sol) suspended form. TDS is not generally considered a primary pollutant (e.g. it is not deemed to be associated with health effects) it is used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of the presence of a broad array of chemical contaminants [16]. The electrical conductivity (EC) ranged between less than 20 µS to more than 40 mS, with the highest value at site 7 and the lowest at sites 1 and 2. Soil electrical conductivity (EC) is a measurement that correlates with soil properties that affect crop productivity, including soil texture, cation exchange capacity (CEC), drainage conditions, organic matter level, salinity, and subsoil characteristics (http://ext.vt.edu/). The oxidation-reduction potential (ORP). ORP referred to as redox potential, can be used as an indicator of the degree of oxidation of sediments. Their values ranged between -27.7mv and -88.8mv. The highest value was recorded at sites 1 and 2. ORP correlated positively with TDS (r=0.54) as in figure (1), and highly negatively correlated with pH (r= 0.99).

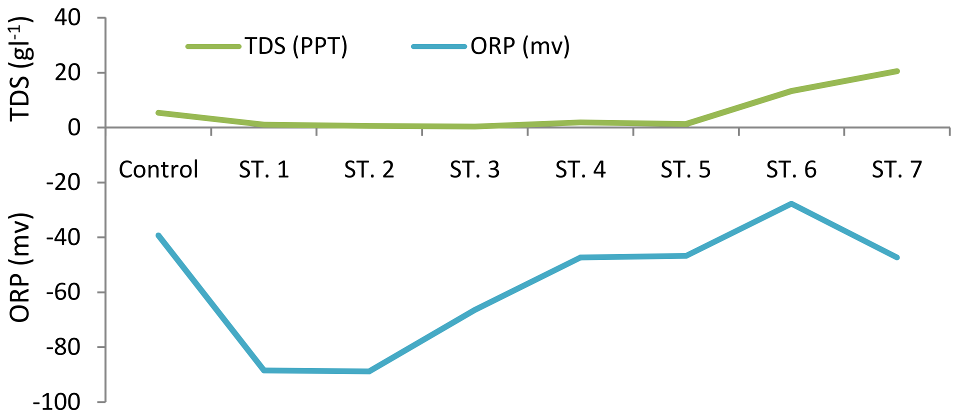

Fig. (1). Correlation between ORP with TDS

Bacteriological characteristics

The results of the total bacterial counts of soil samples collected from various sites at Hail industrial zone are indicated in Table (1). The total bacterial counts mean of soil samples ranged from $5.8x10^8$ (cfu/g) to $2.5x10^6$ (cfu/g), these values were lower than that of the control sample which was $9.2x10^5$(cfu/g). The differences in the averages total bacterial counts of the different sampling were not statistically significant. However, highest counts were observed in sample collected from ST.7, and lowest was found in ST.1. This increase in total bacterial counts could be attributed the accumulation of organic matter, this sampling site has been located in Aledari valley which is exposed to the rain and washing neighbors as well as wastewater from various sources.

The results obtained for the total bacterial counts fell within the range reported by many investigators [17][18][19][20].

Bacteria populations are debilitated by dry conditions, acidity, saltiness, soil compaction and absence of organic matter. Be that as it may, by virtue of certain seed inoculation, it is greatly difficult to gather attractive populations of bacteria just by adding them to the soil. Relationship of high microbial counts with organic matter can be normal, since organic matter likely conveyed with water underpins development of soil microbial groups. Many researchers emphasize the effect of soil structure and spatial isolation on microbial diversity and community structure [21].
A few reviews show that the soil molecule measure influences the differing qualities of microorganisms and community structure to a more prominent degree than different elements, for example, mass pH and the sort or measure of accessible organic compounds [22]. Other reviews show that the type and amount of available organic matter strongly influence the abundance of microbial groups and their functional diversity in soils [23]. Fierer and Jackson [24] guarantee that the structure of soil bacterial groups is not irregular likewise mainland scale and that the differing qualities and composition of soil bacterial communities at large spatial scales can be predicted to a large extent by a single variable, that is soil pH. It has also been reported that in 1 g of the soil sample, there are 4000 different bacterial "genomic units" based on DNA-DNA re-association. It has also been estimated that about 5000 bacterial species have been described [25].

Table 1: Bacteriological characteristics of soil samples

Serial No.	Total bacterial count (cfu/g)	Coliforms (MPN)	Faecal coliforms (MPN)	E. coli (MPN)
Control	$9.2x10^5$	ND	ND	ND
S.T. 1	$2.5x10^6$	ND	ND	ND
S.T. 2	$5.4x10^5$	ND	ND	ND
S.T. 3	$6.4x10^7$	ND	ND	ND
S.T. 4	$8.5x10^4$	ND	ND	ND
S.T. 5	$5.2x10^5$	ND	ND	ND
S.T. 6	$5.5x10^5$	ND	ND	ND
S.T. 7	7.88	$5.8x10^8$	$4.7x10^6$	$9.3x10^2$

Table (1) also show results of the coliforms test. It is obvious that all soil samples were devoid of coliforms bacteria with exception to samples collected from S.T.7 which contained high numbers of coliforms, faecal coliforms and *E.coli*. These samples as had been collected from Aledareh valley which is exposed to the rain and washing neighbors towards the valley. It has been demonstrated that a high number of viable bacterial counts and high organic matter could signify a more diverse groups of bacteria such as coliforms, faecal coliforms and *Escherichia coli* [26][27][28].

Identification of bacteria genera in soil samples

Nine bacterial genera were identified in the various soil sampling sites (Table 2), however, Bacillus genera was the most dominant, while the least genera were Staphylococcus and Chromobacterium. Other bacterial genera included: *Pseudomonas, Proteus, Flavobacterium, Aeromonas, Micrococcus* and *Alcaligenes.* Bacillus bacteria was detected in all sampling sites, and that corresponded with that recorded in the literature. It has been reported that members of the genera ***Bacillus*** have long been considered to be common members of the soil bacterial community [29]. The results also indicated that the occurrence of bacteria genera varied in the various sampling sites, in that ST.1, ST.2, ST.3, ST.4, ST.5, ST.6 and ST.7 contained 4, 5, 4, 5,3, 5 and 7 bacterial genera, respectively compared to the control sample which contained 5 bacterial genera.

Table 2. Presence of various bacterial genera in soil sampling sites

Soil Samples	Bacterial genera
Control	*Bacillus, Pseudomonas, Aeromonas, Micrococcus, Chromobacterium,*
ST.1	*Bacillus, Proteus, Micrococcus, Alcaligenes*
ST.2	*Staphylococcus, Bacillus, Pseudomonas, Proteus, Chromobacterium*
ST.3	*Bacillus, Pseudomona, Aeromonas, Alcaligenes*
ST.4	*Staphylococcus, Bacillus, Pseudomonas, Proteus, Flavobacterium*
ST.5	*Bacillus, Aeromonas, Flavobacterium*
ST.6	*Bacillus, Pseudomonas, Aeromonas, Micrococcus, Alcaligenes*
ST.7	*Staphylococcus, Bacillus, Pseudomonas, Proteus, Chromobacterium, Micrococcus, Alcaligenes*

Soils play critical roles in buffering and filtering freshwater ecosystems. Soil microbes, bacteria, archaea, and fungi play diverse and often critical roles in these ecosystem services. In fact soils influence most ecosystem services on which we depend [30]. The vast metabolic diversity of soil microbes means their activities drive or contribute to the cycling of all major elements (e.g. C, N, P), and this cycling affects the structure and the functions of soil ecosystems as well as the ability of soils to provide services to people. Microbes play a pivotal role in the cycling of nitrogen; they exclusively mediate nitrogen fixation, denitrification, and nitrification [31].

CONCLUSIONS

The results of the present study have revealed the values or percentages of some physico-chemical parameters, and some bacterial counts that can be found in the industrial zone located at the eastern site of Hail city. This area is exposed to chemical and microbiological contamination as a result of Cars maintenance activities. The testing areas are subjected to various levels of physical and bacteriological pollutants that could affect the soil. It is very evident that when the soil is contaminated, the close-by water body would be influenced. Diverse species of bacteria were isolated from Hail industrial zone, Kingdom of Saudi Arabia. The abundance of bacteria in the present study were ordinary of environment with high species abundance and functional diversity.

It is highly recommended to carry out the continuous monitoring of industrial areas and their regions for conceivable transgressions. careful management of land as a resource is essential for meeting a major demand created by accelerated urbanization, industrialization and agricultural development.

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