



Determination of Heavy Metal Concentration and Physicochemical parameters of the Soil samples from Al-Fajr, Thi-Qar Governorate.

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Abstract

The heavy metal contamination of soil has become an important problem due to its both direct and indirect impacts on human health in many parts of the world. In the modern world, metals—and particularly Trace metals represent a major category of contaminants that mostly originate from manufactured and natural sources because of their toxicity and danger to both human life in the ecosystem heavy metal contamination in the environment has gained significant attention trace metals are considered as common pollutants and in recent decades human activities and inputs have substantially raised the concentration of these metals in the environment. The study included collecting soil samples from four locations in the city of Al-Fajr ,Thi-Qar Province to study and evaluate the impact of concentrations of certain heavy metals these elements include lead cadmium copper arsenic and zinc in addition to measuring acidity, TDS ,salinity and electrical conductivity according to the findings the soils had mild alkalinity with pH. values ranging from (7.5 - 7.8), TDS ranging from (1.18 - 6.67 mg/L), salinity (1.36-4.38 mg/L), and EC (2.46–3.3 mmhos /cm) The concentrations of the following heavy metals ranged: Zn (81.3–122.7 ppm), Cu (20.11–41.7 ppm), Cd (0.001–0.012 ppm), As (0.54–1.75 ppm), and Pb (5.41–11.7 ppm). The concentration of the metals in the soil samples exhibited variation in accordance with the subsequent pattern: Zn demonstrated higher concentration than Cu, followed by Pb, As, and Cd. The findings indicate the differences in the concentrations of heavy elements in most of the stations. It was observed that copper exceeded the critical limits, and zinc exceeded the global standard limits. This requires a quick review and comprehensive assessment in those areas.

Keywords: Keywords: Heavy metals, Soil Contaminations, TDS, Al-Fajr



تحديد تركيز العناصر الثقيلة والعوامل الفيزيائية والكيميائية لعينات التربة من الفجر في محافظة ذي قار

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الخلاصة

أصبح تلوث التربة بالمعادن الثقيلة مشكلة مهمة بسبب آثاره المباشرة وغير المباشرة على صحة الإنسان في أجزاء كثيرة من العالم. في العالم الحديث، تمثل المعادن - وخاصة المعادن النزرة - فئة رئيسية من الملوثات التي تنشأ في الغالب من مصادر مصنعة وطبيعية. بسبب سميتها وخطورتها على حياة الإنسان في النظام البيئي، فقد حظي التلوث بالمعادن الثقيلة في البيئة باهتمام كبير. تعتبر المعادن النزرة من الملوثات الشائعة، وفي العقود الأخيرة، أدت الأنشطة والمداخلات البشرية إلى زيادة كبيرة في تركيز هذه المعادن في البيئة. تضمنت الدراسة جمع عينات التربة من أربعة مواقع في مدينة الفجر بمحافظة ذي قار لدراسة وتقييم تأثير تراكيز بعض المعادن الثقيلة وتشمل هذه العناصر الرصاص والكاديوم والنحاس والزرنيخ والزنك، بالإضافة إلى قياس الدالة الحامضية، التوصيل الكهربائي، المواد الصلبة الذائبة و الأملاح. ووفقاً للنتائج، كانت التربة قلوية خفيفة مع قيم pH تتراوح بين (7.5 - 7.8) ، المواد الصلبة الذائبة (1.18 - 6.67 ملغ/لتر)، الملوحة (1.36-4.38 ملغ/لتر)، والتوصيل الكهربائي (2.46-3.3 ملليموس/سم). وقد سجلت معدلات تراكيز العناصر القيم التالية: {الزنك (81.3-122.7)، النحاس (20.11-41.7)، الكاديوم (0.001-0.012)، الزرنيخ (0.54-1.75)، والرصاص (5.41-11.7) جزء في المليون}. أظهرت تراكيز المعادن في عينات التربة تبايناً وفقاً للنمط التالي: الزنك يظهر تركيزاً أعلى من النحاس، تليه الرصاص والزرنيخ والكاديوم. تشير النتائج إلى الاختلافات في تراكيز العناصر الثقيلة في معظم المحطات. لوحظ أن النحاس تجاوز الحدود الحرجة، وتجاوز الزنك الحدود العالمية القياسية مما يتطلب إجراء مراجعة سريعة وتقييم شامل في تلك المناطق.

الكلمات المفتاحية : المعادن الثقيلة ، تلوث التربة ، المواد الصلبة الذائبة ، مدينة الفجر

1. Introduction

Heavy metals are highly persistent in the environment due to their non-biodegradability, thermal stability, and ability to accumulate to dangerous levels even at low concentrations. These metals can constitute a significant health risk to humans and animals because there is no effective mechanism to eliminate them from the body [1–2].

Heavy metals are biodegradable and can accumulate in biological tissues [3]. Long-term exposure to heavy metals can cause cancer in the central and peripheral



neurological systems, in addition to having circulatory effects. High quantities of heavy metals can harm human health; However, only a few of them are important to humans at low concentrations [3]. soil is a very important environmental medium which absorbs substantial amounts of contaminants from many sources throughout time [4].

The issue of heavy metal pollution in soil has Emerged as a significant impressing concern in various regions around the globe due to its Direct and indirect impact on human well-being [5] moreover the presence of these contaminants in the soil serves as an indicator of food toxicity resulting from both human activities and natural occurrences thus leading to their accumulation in agricultural soil soil contamination being devoid of color and scent poses a formidable challenge when it comes to detection rendering a one of the most determinative forms of pollution not only is it resistant to biological decay in characterized by stability but it is also toxic and has the ability to permeate while heavy metals occur naturally in soil there are several natural factors that can contribute to their increased concentration these factors and Compass the smelting of metals the combustion of fossil fuels the utilization of fertilizers and pesticides the introduction of agricultural waste emissions from industrial processes the improper disposal of industrial waste through burial erosion the decomposition of materials and the transportation of exposed rocks as a result of precipitation floods and winds among others [6].

Examining the amounts of specific heavy metals in particular soil samples from the city of Al-Fajr is the study's goal. In addition to measuring the soil's pH, electrical conductivity, and salinity, these samples were also estimated to contain lead, cadmium, arsenic, chromium, and copper, among other heavy metals.

2. MATERIALS AND METHOD

2.1 Samples Collection and Preparation

Collecting and Analyzing Samples, Samples were taken from the four primary sampling stations at Al-Fajar distract during July and August 2023 (Table 2). The soil sample was taken in the vicinity of the sample location at a depth of (5–50 cm). It was then mixed, air dried, and placed into clean, labelled polythene bags, where it was securely stored until the necessary chemical analysis. To ensure homogeneity, the soil samples were combined and sieved over a 2-mm mesh screen. The following characteristics of soil samples were examined: pH, electrical conductivity, salinity, TDS, and heavy metals.

2.2 Determination of Physicochemical Parameters



Analytical standards were met by every chemical and reagent employed. A pH meter was employed to determine the pH of the soil samples in a 1:1 soil water suspension, and a conductivity meter was utilized to measure the electrical conductivity in the water extract filtrate.

2.3 Determination of Heavy metals

The digestion process utilized to determine heavy metals was described by Brigden et al. (2008). For each dried soil sample, 1 g was weighed into a boiling tube 33 that had been rinsed with strong nitric acid (HNO_3) and distilled water. Then, in the boiling tube, each weighed soil sample received 15 ml of a ternary combination (20 ml of concentrated HClO_4 , 500 ml of concentrated HNO_3 , and 50 ml of concentrated H_2SO_4). After that, the samples were digested for 24 minutes in a fume hood using a block digester. Following a cooling period, distilled water was added to each solution, and a Whatman No. 42 filter, 9 cm was used to filter the mixture into a 100 ml Pyrex volumetric flask. Afterwards, distilled water was added to make it up to the mark. After that, the solutions were kept for AAS-based heavy metal analysis.

3 . Results and Discussion

3.1 Physicochemical parameters

Table 2 summarizes the analytical findings for the physicochemical characteristics of several soils. In soil samples, the pH values varied from (7.5 to 7.8) indicating moderately alkaline conditions in all soil samples, which was expected since the pH value of Iraqi soils is typically close to 8.0, given that Iraqi soils are calcareous [8]. The presence of certain metal oxides and the neutralization of soil acidity through a high CaCO_3 content may be the main causes of moderate alkalinity [9]. The pH of the soil plays a crucial role in the dynamics of metal retention due to the primary mechanisms of adsorption and precipitation in soils.

Table 2 also indicates that the high values of electrical conductivity indicate that the soil in this area is highly saline. This means that it contains high concentrations of salts. The high electrical conductivity values are influenced by the high rates of evaporation at the study sites. Evaporation is typically higher in dry-climate areas where there is a lack of water. This increase in evaporation leads to a higher salt concentration in the soil and, consequently, higher electrical conductivity values. [10]. The TDS levels ranged from 1.18 to 6.67 g/L. The concentration of total dissolved solids (TDS) can be represented by the conductivity value. The term TDS refers to the total concentration of dissolved substances in water, which consists primarily of inorganic salts and traces of organic stuff. A high TDS content is a sign that dangerous pollutants like arsenic, iron, manganese, sulfate, and bromide, Their



link is straightforward: electrical conductivity increases with the total amount of soluble salts present. conductivity is a quantification of the capability of an aqueous solution to facilitate the flow of electric current. The conductivity of soil, in turn, is directly proportional to the level of dissolved mineral salts present within it. This property serves as an expedient technique for determining the quantity of salts and dissolved solids in a given solution. Inorganic salts, acids, and bases that are dissolved in water exhibit remarkable conductivity, whereas their organic counterparts demonstrate limited conductivity..

3.2 Heavy Metals

The soil samples were analyzed to determine the concentrations of Zn, Cu, Cd, As, and Pb, which are provided in Table 3 and Figures 1 to 5. The results revealed that all soil samples contained all the heavy metals under investigation. The distribution of heavy metals in soil is continuously altered due to various soil processes and is under the influence of environmental factors. The heavy metal levels were in the following range: Zn (81.3–122.7 ppm), Cu (20.11–41.7 ppm), Cd (0.001-0.012 ppm), As (0.54–1.75 ppm), and Pb (5.41–11.7 ppm). When comparing the results of the current study with local and international studies, we find that the concentration of zinc recorded the highest levels (122.7 ppm) among these elements. This value is higher than the local standards set in Iraq [11] and higher than international standards by 50 ppm. [12] It is common to find higher concentrations of arsenic in areas that suffer from poor healthcare and environmental services, as well as high human activities. This is further exacerbated by the disposal of sewage into the soil and groundwater, as well as the accumulation of household waste that often contains arsenic and multiple sources compared to other elements [13], also been confirmed that the arsenic content in soil varies widely, and this can be attributed to the rocks from which the soil originated [14].

Copper, the second most prevalent heavy metal Following zinc surpassed the established thresholds in the regions examine the elevated levels of copper may be attributed to anthropogenic activities such as industrial processes agricultural practices and the use of copper based pesticides copper is an essential micro nutrient for plants but at high concentrations it can become toxic and have detrimental effects on soil quality and organisms [15].cadmium (CD) on the other hand remained within the regulatory limits during the study cadmium (CD) exhibited relatively lower concentrations compared to zinc cadmium is a toxic heavy metal that can originate from various sources including industrial processes agricultural practices and atmospheric deposition the lower concentrations of cadmium may indicate relatively less contamination or lower inputs of this element in the studied soils this suggests that the concentrations of cadmium in the studied soils were considered acceptable



according to the established standards 12 the maximum permissible limits for metals in the soil samples from farmlands as stated by the FAO who in 2007 in the EU standards in 2002 are identified as Cu-265 in CD- 3.0

Arsenic (As) and lead (Pb) showed Intermediate levels among the heavy elements study arsenic can be derived from both natural and anthropogenic sources including volcanic activity mining in the use of arsenic containing pesticides lead is commonly associated with industrial activities such as lead acid battery manufacturing and lead-based paint the high levels of lead in the soil rays concerns due to its toxicity and potential adverse effects on human health in the environment the variations in the concentrations of these heavy elements can be influenced by characteristics such as proximity to pollution sources land use practices and historical contamination [17].

continuous monitoring and assessment of heavy metal levels in soils are essential to identify potential risks and implement appropriate remediation measures to protect human health and the environment zinc was the most prevalent medal in all soil samples while CD was the least prevalent with metal concentrations in the samples generally following the following trend $Zn < Cu < Pb < As < Cd$.

Table (1): Description of study stations.

Stations	The location
St.1	It is located north of the city of Al-Fajr at a longitude of 45.95° east and a latitude of 31.92° north. This area is characterized by agricultural lands
St.2	It is located west of the city of Al-Fajr at a longitude of 45.94° east and a latitude of 31.91° north.
St.3	It is located east of the city of Al-Fajr at a longitude of 45.96° east and a latitude of 31.92° north.
St.4	It is located south of the city of Al-Fajr at a longitude of 45.96° east and a latitude of 31.90° north

Table (2) shows the values of Physicochemical parameters.

Stations	PH	TDS(mg/L)	Salinity (mg/L)	EC (mmhos/cm)
St.1	7.77	1.18	1.36	2.73
St.2	7.7	3.65	2.74	2.46
St.3	7.5	3.27	3.55	3.18
St.4	7.8	6.67	4.38	3.3



Table (3): Concentrations of Heavy Metals in the study area

Stations	Zn concentration (ppm)	Cu concentration (ppm)	Cd concentration (ppm)	As concentration (ppm)	Pb concentration (ppm)
St.1	102.7	20.11	0.0017	1.75	6.36
St.2	121.7	35.4	0.012	0.54	9.2
St.3	122.7	41.7	0.0019	1.36	5.41
St.4	81.3	27.8	0.001	0.99	11.7

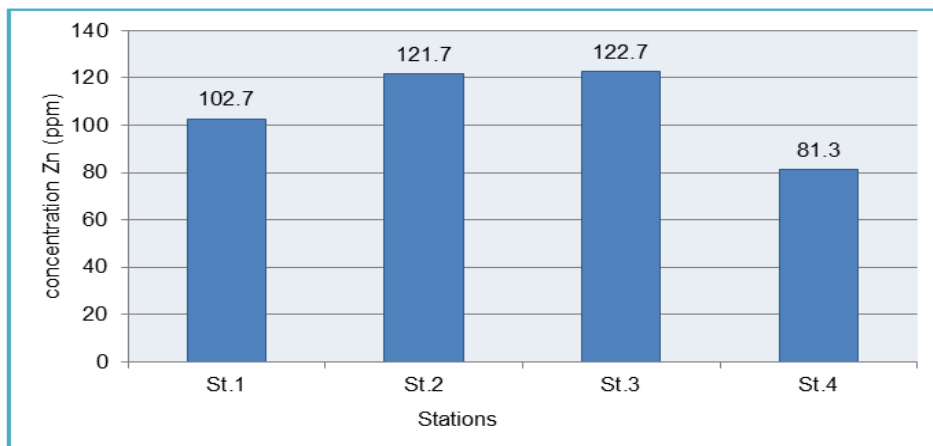


Figure 1: Zinc concentration in study Stations

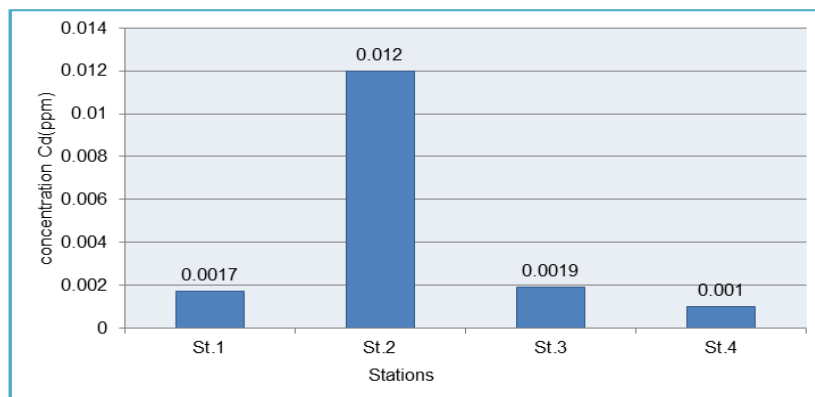


Figure 3: Cadmium concentration in study Stations

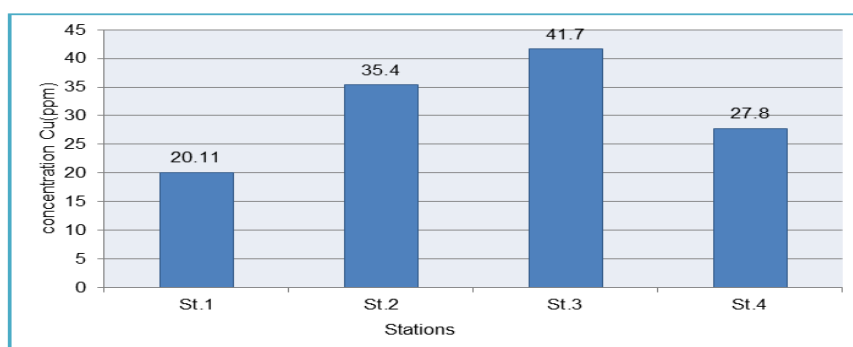


Figure 2: Copper concentration in study Stations

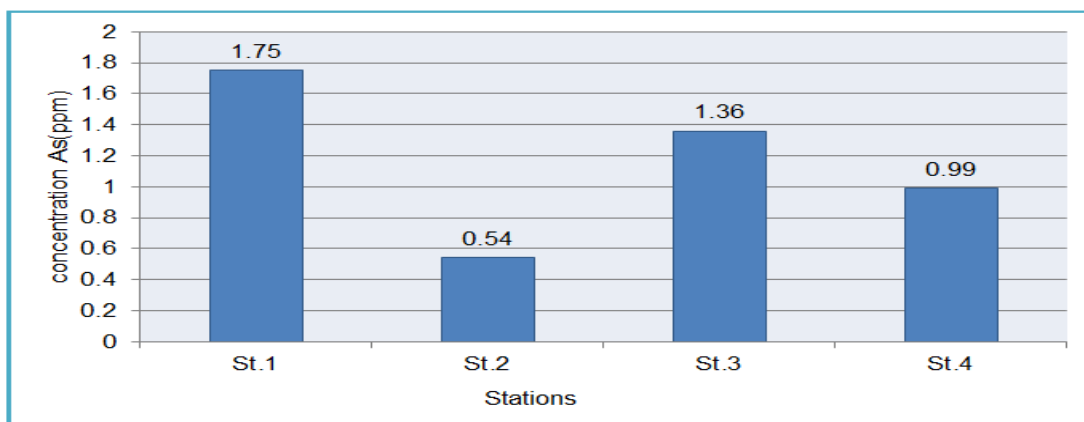


Figure 4: Arsenic concentration in study Stations

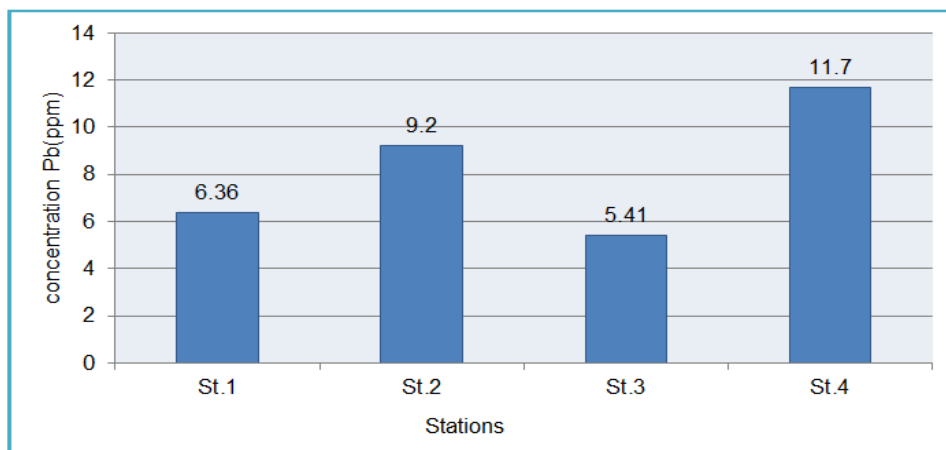


Figure 5: Lead concentration in study Stations

4. CONCLUSION

The analysis of physiochemical factors is imperative for the development of plants and the management of soil these investigations into the pH level nutrient composition and cations with industrial activities this is crucial for both safeguarding that the well-being of agricultural production and ensuring food security while also contributing to the overall reduction of pollution in the course of the study it is essential to select a suitable location that is surrounded by contaminants the soil being analyzed remains healthy and unaffected by hazardous impacts additionally it is vital to employ the most suitable method of analysis in order to obtain accurate and reliable information.

The study recommends the continuation of environmental monitoring to identify pollution sources establish stringent environmental regulations and conduct comprehensive assessments and thorough reviews of the environmental situation this should be done alongside awareness campaigns and providing financial and moral support which would contribute to the preservation of a healthy environment.

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