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PHYSICO-CHEMICAL ESTIMATION FOR DIFFERENT SOILS AND THEIR EVALUATION OF THE AVAILABLE COPPER, ZINC, AND MANGANESE

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ABSTRACT: The soil is the multiple crucial components in satisfying all the essential necessities of mortal beings and is a significant segment of our agriculture. The study was executed with the principal pursuit of scrutinizing the soil samples for their physicochemical analysis and their total and available contents of Cu, Zn, and Mn. Mineralogical analyses of the three soil samples of Hihia, El-Noubaria, and El-Khattara regions were carried out using wet chemical analyses and X-ray diffraction measurements. Besides, the physicochemical analyses that are particle size distribution, cation exchange capacity (CEC), electrical conductance (EC), organic matter (OM), soil pH, CaCO₃ contents, soluble cations, and anions of the studied soil samples were applied. The results revealed that the textures of Hihia, El-Noubaria, and El-Khattara soils were clayey, sandy loam, and sandy, respectively. The conductivities were 2.10, 3.72, and 0.75 dSm⁻¹, while the CaCO₃ values were 58.00, 171.00, and 18.8 gkg⁻¹. Besides, the soil pH values of the clayey, sandy calcareous, and sandy soils are 8.21, 8.11, and 8.34, respectively; hence the soils were alkaline. Moreover, the atomic absorption technique measured the total and available contents of Cu, Zn, and Mn of the three soils. Copper, zinc, and manganese were extracted from soils using diethylene triamine pentaacetic acid (DTPA). The data obtained were compared with the global permissible limits higher than the DTPA-extractable Cu, Zn, and Mn contents. Hence, the studied soils are safe and suitable for cultivating many crops and fruit trees.

Key words: Soil analysis, pH, EC, Copper, Zinc, Manganese, DTPA-extractable.

INTRODUCTION

In a developing nation such as Egypt, one of the main challenges of modest agricultural growth is sustaining ecosystem benefits to make safe food (Abuzaid and Jahin, 2019). These demands ongoing and episodic monitoring of soil breakdown because the soil is a principal source and sink of contaminants (Elbana *et al.*, 2019). Soil corruption is the assemblage of any born or instructed substance to a contaminated level. Among different materials, poisonous metals are widespread contaminants that decompose soil grade (Kong, 2014). They happen inherently in soil parent rocks and/or penetrate the soil system *via* fertilizers, poor-quality water irrigation, pesticides, contaminated

air ejected from industrial actions, and inappropriate solid waste removal. When surpassing the crucial limit, these toxicants are contaminated with living organisms (Ali *et al.*, 2018).

Heavy metals are also guided in scientific works as metal contamination of soil that are one of the multiple pressing circumstances in the discussion about food assurance and safeness globally (Bolan *et al.*, 2014). A recent assessment outlines the influence of heavy metals from food origin on human healthiness, and the mechanism of uptake, bioaccumulation, and transformation of heavy metals by plants. Heavy metals constitute an ill-defined group of inorganic chemical hazards. Those most naturally located at impure sites are Zn, Mn, Cd, Pb, Cr, Ni, Hg,

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Cu, and As. Soils are the primary sink for heavy metals released into the environment by the aforementioned anthropogenic activities. Unlike organic impurities, which are oxidized to carbon dioxide by microbial activity, most metals do not undergo microbial or chemical degradation (Kirpichtchikova *et al.*, 2006), and their total concentration in soils persists for a long time after their introduction (Adriano, 2003).

Huang *et al.* (2017) studied the impacts of heavy metal contamination that get into the environment by manipulating site simulations of smelter contamination. Heavy metal contamination that does get into the environment could cause permanent adverse ecological effects (Khalifa and Gad, 2018). These pollutants can be maintained by plants and enter the food chain of animals and humans. Examinations have found that cattle that graze on metal-contaminated plants will accumulate toxic metals in their bodies, which could be passed to humans (Kowalska *et al.*, 2018). Therefore, environmental heavy metal contamination has become an area of increasing concern. Heavy metal pollution is accountable for several environmental difficulties and risks to human health. Hence, using plants polluted with high levels of heavy metals for food might pose a severe risk to human and animal health (Palansooriya *et al.*, 2020).

The adequate protection and restoration of soil ecosystems contaminated by heavy metals require their characterization and remediation. Recent legislation respecting environmental protection and public health, at both national and international levels, is established on data that characterize the chemical properties of environmental phenomena, especially those that reside in our food chain (Kabata-Pendias and Pendias, 2001). While soil characterization would provide an insight into heavy metal speciation and bioavailability, an attempt at remediation of heavy metal contaminated soils would entail knowledge of the source of contamination, introductory chemistry, and environmental and associated health effects (risks) of these heavy metals. Risk assessment is an effective scientific tool (Zwolak *et al.*, 2019) that enables decision-makers to manage contaminated sites cost-effectively while preserving public and ecosystem health.

This work aimed to assess the mineralogical and chemical characteristics of clayey, calcareous, and sand soils. The physicochemical analyses of the studied soil samples were applied, including particle size distribution, cation exchange capacity, electrical conductance, organic matter, soil pH, active CaCO₃ contents, soluble cations, and anions. Furthermore, the total and available contents of Cu, Zn, and Mn were evaluated for the collected soil samples.

MATERIALS AND METHODS

Soil Preparations

Three soil samples were used and collected from the surface soils (0 – 30 cm). 1) A clayey soil sample was obtained from the Hihia region, El-Sharkia Governorate. 2) calcareous soil was gained from the El-Noubaria area, the Northern part of the Tahreer Province. 3) A sandy soil was attained from the farm of the Faculty of Agriculture at El-Khattara, Zagazig, University, El-Sharkia Governorate. Soil samples were air-dried, crushed with a wooden roller, sieved through a 2 mm plastic screen, thoroughly mixed, and stored in plastic sacks for further analysis and experimental work.

Soil Organic Matter

Soil organic matter was determined by the chromic acid method of Walkely and Black according to Jackson (1973).

Soil pH

Soil pH was measured using glass electrode pH meter in a soil water suspension (Cottenie *et al.*, 1982).

Cation Exchange Capacity

Cation exchange capacity in the collected soil samples was also determined using the sodium acetate–ammonium acetate method (Ross and Kettering, 2011).

Mineralogical and Major Analyses

Bulk soil samples were analyzed using X-ray diffraction (XRD) patterns that were recorded on a Bruker D8 Advance X-ray diffractometer with a Cu-K α anode ($\lambda = 0.1542$ nm) operating at 40 kV and 30 mA. The diffraction patterns

were collected at 25°C and over an angular range of 3 to 70° with a step size of 0.05°/step and a 12 sec/increment dwell time. Major elements (Si, Al, and P) were analyzed using a UV/VIS spectrophotometer (UV-5200, USA) (Cheira, 2020a; Allam *et al.*, 2022a). In contrast, Na and K ions were analyzed using a flame photometer. Fe, Mg, and Ca ions were analyzed utilizing the traditional complex titrimetric technique using Na₂EDTA (Shapiro and Brannock, 1962; Cheira *et al.*, 2020; Allam *et al.*, 2022b; Sakr *et al.*, 2022).

Methods of Chemical Analyses

Electrical conductance was measured using an electrical conductivity bridge in the studied soils' collected extract (1: 2.5). Soluble calcium and magnesium ions were determined by titration with Na₂EDTA (Cheira, 2020b; Atia *et al.*, 2021; Hassanin *et al.*, 2021). A Flame photometer determined soluble sodium and potassium ions. Soluble carbonate and bicarbonate ions were determined by titration with HCl. Soluble chloride ions were determined by titration with silver nitrate. The mechanical soil analysis was carried out by particle size distribution. Total carbonates were evaluated volumetrically and calculated as calcium carbonate (Baruah and Barthakur, 1997).

Total contents of the heavy metals (Cu, Zn, and Mn) in the studied soils were extracted as Tessier *et al.* (1979) described. One gram of each soil sample was digested in a Teflon beaker with a solution of concentrated HClO₄ (ratio 1:1, acid: distilled water) and HF (ratio 1:1, acid: distilled water) to near dryness. Finally, HClO₄ (ratio 1:1, acid: distilled water) was added and evaporated till the appearance of white fumes. The residue was dissolved in concentrated HCl and diluted to 25 mL. Then the tested metals were determined in the clear solution using the atomic absorption spectrophotometer model (GBC 932).

The chemically available portion of heavy metals (Cu, Zn, and Mn) in the studied soils was determined by the method described by Lindsay and Norvell (1978). This method could be summarized as follows; 10 g of each soil sample was shaken for two hours with 20 mL of an extracting solution. The extracting solution

consists of 0.005 M DTPA (diethylene triamine pentaacetic acid), 0.01 M CaCl₂ and 0.1 M TEA (triethanolamine) at pH 7.3. The clear solutions were analyzed for the tested heavy metals using atomic absorption spectrophotometer (GBC 932).

RESULTS AND DISCUSSION

Physico-Chemical Analysis

Particle size distribution

The texture classes were determined using the textured triangular diagram. Soil suspension at a given depth becomes less as the particle settles. Its value at a different time is related empirically to particle size so that, by the selection of times, a density can be a measure of sand, clayey, and silt. As indicated in Table 1, soil texture was different for all samples. The particle size distribution of the soil showed that the soil contained higher composition of clayey than silt and sand in the clayey soil of the Hihia area, El-Sharkia Governorate. Hence, the texture class is clayey.

Moreover, the soil particle size distribution presented that the soil contained a medium texture in the calcareous soil due to the composition of sand (60.33%), silt (21.16%), and clayey (18.51%) in the calcareous soil of El-Noubaria area, the Northern part of the Tahreer Province. Therefore, the texture class is sandy loam. In contrast, the soil particle size distribution offered that the soil included texture in the sandy soil due to the higher composition of sand (92.47%) in the farm of the Faculty of Agriculture at El-Khattara, Zagazig University, El-Sharkia Governorate. Consequently, the texture class is sand.

Cation exchange capacity

Cation exchange capacity measures the cations that can be adsorbed and held by the soil. CEC is used to measure fertility, nutrient retention capacity, and the capacity to protect groundwater from cation contamination. CEC is dependent on the organic carbon and clayey in the soil. In universal, the higher the organic carbon and clayey content, the higher the CEC. CEC is a vital soil parameter because it indicates the type of clayey mineral present in the soil and

its capacity to retain nutrients against leaching (Aprile and Lorandi, 2012). The CEC of the clayey soil sample was $27.80 \text{ cmol}_c\text{kg}^{-1}$. Hence, soil indicates its high capacity to retain the cations. While the CEC of the calcareous and sand soil samples was 9.5 and $3.48 \text{ cmol}_c\text{kg}^{-1}$, therefore, the soils indicated their moderate and low capacity to hold the cation, respectively.

Electrical conductance

Conductivity measures the ability of the aqueous solution to carry an electric current that depends on the presence and total concentrations of ions, their mobility and valance, and temperature (Salem *et al.*, 2020). Here, the conductivities of the three soil samples were determined at 25°C . In the collected soil samples, clayey, calcareous, and sandy, the conductivities were 2.10, 3.72, and 0.75 dSm^{-1} , respectively (Table 1). The relatively low electrical conductivity was observed in sandy soil, and the relatively highest electrical conductivity was observed in calcareous ore. Therefore, sandy soils can give a toxic amount of metal from a small amount of soil. Moreover, McBride and Murray (1994) indicated that soils with low electrical conductivity (EC) could give a toxic quantity of metal from a small quantity of soil.

Organic matter

Data in Table 1 exhibited that the organic matter (OM) content of the sand soil sample is low (1.28 gkg^{-1}) while the OM in the clayey and calcareous soil samples is high (12.46 and 9.31 gkg^{-1}), respectively.

Soil pH

The pH is a measurement of the alkalinity and acidity of soil water. The pH value is naturally impacted by the rate of salts in the soil, which results from the leaching solution of soil and/or the intrusion of seawater. The pH values of the clayey, calcareous, and sandy soils are 8.21, 8.11, and 8.34, respectively (Table 1). Based on Bahiru and Teju (2019), soils with the pH ranges of 5.6-6.0, 6.1-6.5, 6.6-7.4, 7.4-7.8, and 7.8-8.4 are moderately acidic, slightly acidic, neutral or nearly neutral, slightly alkaline and moderately basic respectively; likewise, soils with pH above 8.5 are strongly alkaline. As a result, the studied soil samples were moderately alkaline.

CaCO₃ contents

The calcium carbonate content of these soils plays a significant role in their formation and, consequently, their physicochemical characteristics. The active CaCO₃ values of clayey, calcareous, and sand soils are 58.00, 171.00, and 18.80 gkg^{-1} , respectively. Obviously, the proportion of the active fraction of calcareous soil was generally higher than the active fraction of clayey and sand soils. These data agreed with the XRD, which showed the presence of calcite (CaCO₃) in calcareous soil. Hence, the distribution and amount of carbonates influence soil fertility. The increase of calcium carbonate in the soil led to a considerable decrease in the availability of most nutrients (Abou El-Anwar *et al.*, 2019). In comparison, carbonate minerals cause the immobilization of metals by providing an adsorbing and nucleating surface.

Soluble cations and anions

Considering the cationic distribution, data show that the salt composition is dominated by calcium, followed by magnesium and sodium, while potassium represents the lowest component. In the clayey soil, the values 7.72, 5.91, 6.90, and $0.28 \text{ mmol}_c\text{L}^{-1}$ are calcium, magnesium, sodium, and potassium, respectively, while in the calcareous soil, the concentration values of Ca²⁺, Mg²⁺, Na⁺, and K⁺, are 21.77, 2.24, 10.04, and $0.99 \text{ mmol}_c\text{L}^{-1}$, respectively. Moreover, in the sandy soil, Ca²⁺, Mg²⁺, Na⁺, and K⁺ concentration values are 3.11, 0.97, 3.85, and $0.94 \text{ mmol}_c\text{L}^{-1}$, respectively.

Anionic compositions of the soil adhesive extract display that the main anion is the chloride, followed by bicarbonate and sulfate ions; their concentrations in the clayey soil are from 9.86, 2.82 and $8.13 \text{ mmol}_c\text{L}^{-1}$, respectively. Nonetheless, these anions concentrations in the calcareous soil are also 7.26, 3.88 and $23.90 \text{ mmol}_c\text{L}^{-1}$, respectively. The corresponding anions values are 2.26, 1.97, and $4.64 \text{ mmol}_c\text{L}^{-1}$ in sandy soil, respectively.

These results designate that the soluble salts are mostly sodium chloride, magnesium chloride, and sodium sulfate. But an extensive content of potassium chloride exists in the clayey soil. Also, calcium chloride and sodium sulfate are primarily present in higher proportions than magnesium chloride in the calcareous soil. In contrast, calcium chloride, sodium sulfate, and magnesium chloride are low in sandy soil.

Table 1. Some characteristics of the studied soil samples

Characteristic	Hihia	El- Noubaria	El-Khattara
Particle size distribution, %			
Sand	30.05	60.43	92.67
Silt	21.00	21.16	6.19
Clayey	49.11	18.51	1.34
Texture class	Clayey	Sandy loam	Sand
CEC, cmolckg ⁻¹	27.80	9.5	3.48
EC _e , dSm ⁻¹	2.10	3.72	0.75
pH (1:2.5)	8.21	8.11	8.34
OM, gkg ⁻¹	9.31	12.46	1.28
CaCO ₃ , gkg ⁻¹	58.00	171.00	18.80
Soluble ions, mmolL⁻¹			
Ca ²⁺	7.72	21.77	3.11
Mg ²⁺	5.91	2.24	0.97
Na ⁺	6.90	10.04	3.85
K ⁺	0.28	0.99	0.94
Cl ⁻	9.86	7.26	2.26
HCO ₃ ⁻	2.82	3.88	1.97
CO ₃ ²⁻	-	-	-
SO ₄ ²⁻	8.13	23.90	4.64

Mineralogical Analysis of Soil

Chemical composition analyses

The main chemical components of the studied soil samples are in Table 2. The chemical analysis of clayey soil were SiO₂ (48.28%), Al₂O₃ (18.95%), Fe₂O₃ (3.97%), MgO (3.12%), CaO (6.52%), Na₂O (2.73%), K₂O (1.54%) and P₂O₅ (2.65%). Besides, the chemical composition of calcareous soil were SiO₂ (22.59%), Al₂O₃ (9.52%), Fe₂O₃ (6.89%), MgO (11.67%), CaO (22.72%), Na₂O (1.72%), K₂O (0.26%) and P₂O₅ (0.51%). Moreover, the chemical constituents of sandy soil were SiO₂ (78.72%), Al₂O₃ (5.56%), Fe₂O₃ (4.98%), MgO

(1.13%), CaO (2.46%), Na₂O (0.48%), K₂O (0.95%) and P₂O₅ (1.23%).

From these data, the highest content of SiO₂ was in sandy soil, but the lowest content of SiO₂ was in calcareous one. However, the highest content of CaO and MgO was in calcareous soil due to the presence of carbonate minerals (such as calcite and dolomite). The highest content of P₂O₅ was found in the clayey soil because of the continuous fertilization with phosphate fertilizer. In contrast, the total contents of Cu, Zn, and Mn ions were 178, 195, and 4900 mgkg⁻¹ in clayey soil, besides the total values were 128, 147, and 3000 mgkg⁻¹ in calcareous soil, while in sandy soil, the total values were 81, 90, and 2000 mgkg⁻¹, respectively.

Table 2. Total chemical analysis of the studied soil samples

Constituent	Clayey	Calcareous	Sandy
Major oxides (%)			
SiO ₂	48.28	22.59	78.72
TiO ₂	0.39	0.11	0.27
Al ₂ O ₃	18.95	9.52	5.56
Fe ₂ O ₃	3.97	6.89	4.98
MgO	3.12	11.67	1.13
CaO	6.52	22.72	2.46
Na ₂ O	2.73	1.72	0.48
K ₂ O	1.54	0.26	0.94
P ₂ O ₅	2.65	0.51	1.23
L.O.I	11.37	23.13	3.51
Total	99.52	99.12	99.28
Trace elements (mg.kg⁻¹)			
Cu	178	128	81
Zn	195	147	90
Mn	4900	3000	2000
Rb	123	456	45
Sr	59	542	188
Br	52	158	99
Ni	28	258	156
Cr	99	134	155
V	142	135	57

L.O.I: loss on ignition; the amount that the sample lost on ignition at 1000 °C, usually including H₂O and CO₂.

X-ray diffraction analyses

The mineralogy of selected soils was determined by X-ray diffraction (Bruker D8 Advance) analysis between 3-70°. Samples were scanned at 40 kV and 50 mA using Cu-Kα radiation. Fig. 1 displays the XRD pattern of clayey soil. The agricultural clayey soil sample consist of microcline (KAlSi₃O₈), quartz (SiO₂), montmorillonite (NaMgAlSi₂O₇ (OH) H₂O), albite (NaAlSi₃O₈), and kaolinite (Al₂Si₂O₅ (OH)₄). However, the X-ray diffraction pattern in Fig. 1 exposed that the calcareous soil sample comprised of microcline (KAlSi₃O₈), quartz (SiO₂), calcite (CaCO₃), kaolinite (Al₂Si₂O₅ (OH)₄), gypsum (CaSO₄.2H₂O), dolomite (CaMg (CO₃)₂) and illite (K(AlFe)₂ AlSi₃O₁₀ (OH)₂.H₂O). In contrast, Fig. 1 revealed that the sandy soil sample includes quartz (SiO₂),

microcline (KAlSi₃O₈), albite (NaAlSi₃O₈), and aluminum silicate (Al₂SiO₅).

The XRD results concluded that the clayey minerals montmorillonite and kaolinite were present at higher amounts in clayey soil. However, calcite, gypsum, and dolomite were also observed at higher amounts in calcareous soil. On the other hand, the XRD results concluded that the quartz was present at higher amounts in sand soil.

Total and DTPA-extractable heavy metals in soils

The total and DTPA-extractable concentration of heavy metals (Cu, Zn, and Mn) in clayey, calcareous, and sandy soils was evaluated. The conveyed data are offered in Table 3, which illustrates that all the three soil samples are

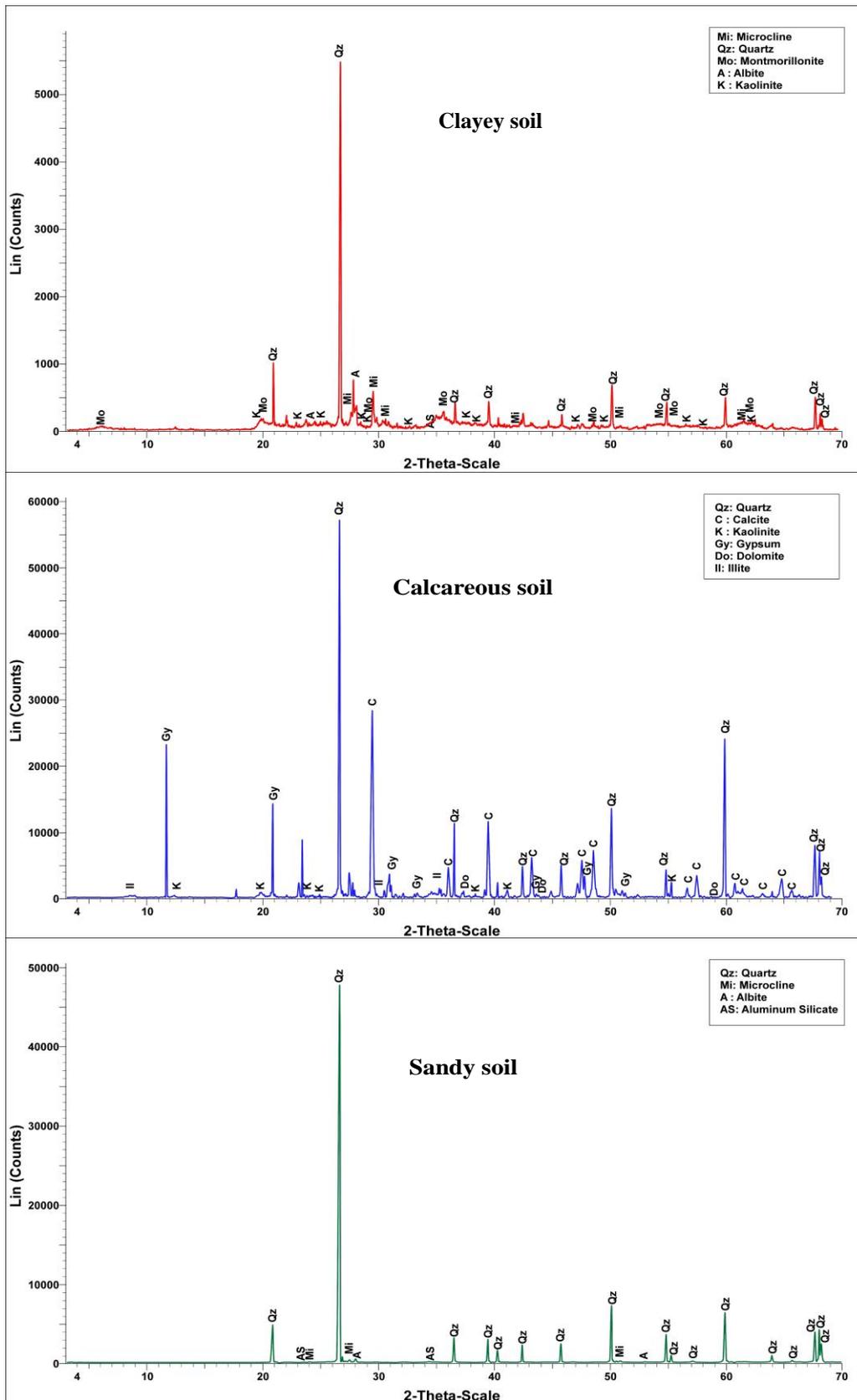


Fig. 1. XRD pattern of examined soil samples under study

Table 3. Total and available DTPA-extractable of Cu, Zn, and Mn (mg kg⁻¹) in the studied soils

Soil	Copper (mgkg ⁻¹)		Zinc (mg kg ⁻¹)		Manganese (mg kg ⁻¹)	
	Total	DTPA	Total	DTPA	Total	DTPA
Clayey	178	30	195	30	4900	31
Calcareous	128	23	147	23	3000	20
Sand	81	9	90	9	2000	15

supported for Cu, Zn, and Mn ions. Referring to permissible boundaries of heavy metals values in farming soils, assessed by the European Economic Commission (Linzon, 1987; Kabata-Pendias and Pendias, 1992), described; total Cu (50-100 mgkg⁻¹), Zn (150-300 mgkg⁻¹), and Mn (100-260 mgkg⁻¹).

The result revealed that Cu concentrations in clayey and calcareous soils were 178 and 128 mgkg⁻¹, higher than the permissible range for agricultural soil. In comparison, Cu concentration in sand soil was 81 mgkg⁻¹, which was between the minimum and maximum permissible limit. Moreover, Zn concentrations in clayey, calcareous, and sand soils were 195, 147, and 90 mgkg⁻¹, found in the permissible values. Moreover, the Mn concentrations in clayey, calcareous, and sand soils were 4900, 3000, and 2000 mgkg⁻¹, which were also higher than the permissible value. The high concentration of the studied heavy metals displayed that metal and its compound are obtained from the used fertilizers.

The DTPA-extractable heavy metal contents (available Cu, Zn, and Mn) of clayey, calcareous, and sand soils were gained in Table 3. The available Cu for clayey, calcareous, and sandy soils were 30, 23, and 9 mg.kg⁻¹, which showed a lower than the acceptable range in cultivated soil. Also, the results of the DTPA-extractable Zn in the studied soils show that the level of DTPA-extractable Zn in the studied soils were 30, 23, and 9 mg.kg⁻¹, respectively. The lowest values of available zinc were related to calcium carbonate and the higher pH of the soils. Generally, DTPA extractable zinc levels decreased with increasing pH and calcium carbonate content. Besides, the available Mn for clayey, calcareous, and sandy soils were 31, 20,

and 15 mgkg⁻¹, which showed a lower than the acceptable range in cultivated soil.

The lower extractability of the heavy metals involved in the study can be attributed to the increased difficulty of extraction of these heavy metals due to the lack of their extraction and their increased association with the studied soil contents, along with the relatively high pH values for the soils. Several authors have documented that the solubility of most heavy metals, solubility processes, and precipitation of soil minerals are controlled by soil pH (Barrow 1986). Although other soil scientists believe that soil chemistry is also essential in controlling the long-term solubility of trace elements, (El-Arby and Elbordiny, 2006) ignore soil properties. The studied soils are safe and suitable for cultivating many crops and fruit trees from the obtained data.

Conclusion

Soil is one of the essential features of the environment that influence plants' development and growth. Soil testing is one of the chemical processes in which the practicality of vital nutrients is determined before planting the crops so that the need for a remaining nutrient can be fulfilled artificially by applying fertilizer in the field. The examination was executed to explore some of the physico-chemical characteristics of the studied soils. Soil chemical analyses and X-ray diffraction were determined. Besides, the physicochemical characteristics, including particle size distribution, cation exchange capacity, electrical conductance, organic matter, soil pH, active CaCO₃ contents, and soluble cations and anions of the studied soil samples, were determined. Results showed that the texture of the soils collected from Hihia, El-Noubaria, and El-Khattara areas were clayey,

sandy loam, and sand with alkaline nature. The XRD results concluded that the clayey minerals montmorillonite and kaolinite were present in higher amounts in clayey soil. However, calcite, gypsum, and dolomite were also observed at higher amounts in calcareous soil. Moreover, the XRD results concluded that the quartz was present higher in sandy soil.

The soils were tended to high pH values. Moreover, the atomic absorption technique measured the total and available contents of Cu, Zn, and Mn ions of the three soils. Copper, zinc, and manganese (Mn) were extracted from soils using diethylene triamine pentaacetic acid (DTPA). The data obtained were compared with the global permissible limits which higher than the DTPA-extractable Cu, Zn, and Mn contents. Hence, the studied soils are safe and suitable for cultivating many crops and fruit trees. The purpose of the work was to investigate the grade of the soil so that it may be adjusted according to the needs to maximize soil productivity.

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التقدير الفيزيائي-الكيميائي للأراضي المختلفة وتقييم محتوى النحاس والزنك والمنجنيز المتاح

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التربة هي إحدى السمات الأساسية للبيئة التي تؤثر على نمو النباتات وإنتاجية المحاصيل الزراعية. يعد اختبار التربة إحدى العمليات الكيميائية التي يتم فيها تحديد مدى فعالية العناصر الغذائية الحيوية قبل زراعة المحاصيل بحيث يمكن تلبية الحاجة إلى العناصر الغذائية المتبقية بشكل مصطنع عن طريق استخدام الأسمدة في الحقل. تم إجراء الفحص لإستكشاف بعض الخصائص الفيزيائية والكيميائية للتربة المدروسة. تم تحديد التحليلات الكيميائية للتربة وانحراف الأشعة السينية. بالإضافة إلى ذلك، تم تحديد الخصائص الفيزيائية والكيميائية بما في ذلك توزيع حجم المادة، وسعة التبادل الكاتيوني، والتوصيل الكهربائي، والمواد العضوية، ودرجة الحموضة في التربة، ومحتويات كربونات الكالسيوم النشطة، والكاتيونات والأنيونات القابلة للذوبان في عينات التربة المدروسة. أظهرت النتائج أن قوام التربة التي تم جمعها من مناطق هيبيا والنوبارية والخطارة كانت طينية وطينية - رملية ورملية ذات طبيعة قلبية. خلصت نتائج XRD إلى أن معادن المونتموريلونيت والكاولينيت كانت موجودة بكميات أعلى في التربة الطينية. كما لوحظ وجود الكالسيوم والجبس والدولوميت بكميات أعلى في التربة الجيرية. علاوة على ذلك، خلصت نتائج XRD إلى أن الكوارتز كان أعلى في التربة الرملية. محتوى المادة العضوية لعينة التربة الرملية منخفض (1.28 جم/كجم) بينما في عينات التربة الطينية والجيرية عالية (12.46 و 9.31 جم/كجم) على التوالي. كانت درجة التوصيل الكهربائي هي 2.10 و 3.72 و 0.75 (dS.m^{-1})، بينما كانت قيم كربونات الكالسيوم 58 و 171 و 18.8 جم/كجم. إلى جانب قيم الأس الهيدروجيني للتربة في التربة الطينية والجيرية والرملية هي 8.21 و 8.11 و 8.34 على التوالي، وبالتالي كانت التربة تميل للقلبية. علاوة على ذلك، تم قياس المحتوى الكلي والمتاح من أيونات النحاس والزنك والمنجنيز في الأراضي الثلاثة بتقنية الامتصاص الذري. تم استخلاص النحاس والزنك والمنجنيز (Mn) من التربة باستخدام ثنائي إيثيلين تري أمين بنتا حمض الأسيتيك (DTPA)، وتمت مقارنة البيانات التي تم الحصول عليها مع الحدود العالمية المسموح بها والتي كانت أعلى من محتويات النحاس والزنك والمنجنيز القابلة للاستخراج. ومن ثم فإن التربة المدروسة آمنة وجيدة لزراعة العديد من المحاصيل والأشجار المثمرة. كان الغرض من العمل هو فحص درجة التربة بحيث يمكن تعديلها وفقاً للاحتياجات لتعظيم إنتاجية التربة.

المحكمون:

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