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Impact of Oxides and Physiochemical Properties of Agricultural Soil on Bioaccumulation of Toxic Heavy Elements in Wheat Grains in Yaychi, Northeast of Iraq

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Abstract

To investigate the potential link between toxic heavy elements in soil with soil physiochemical properties and oxides, as well as their impact on the bioaccumulation of these elements in wheat grains. Agriculture soil and wheat grains were sampled from Yaychi area, Kirkuk northeast of Iraq. Soil physiochemical properties, oxides and toxic heavy elements contents were determined. The average concentration of toxic heavy elements in soil was in this order Ni > Cr > Pb > As > Cd > Hg, and some of these elements had exceeded their average in earth's crust and Canadian Agricultural Soil Quality Guidelines. While in wheat grains the toxic heavy elements, contents were in the following order Cr > Ni > Pb > As > Cd > Hg. The soil physiochemical properties in the study area are shown to be medium alkaline, non-saline, calcareous, non-gypsiferous, inorganic and loam texture. It became clear from the correlation matrix that the toxic heavy elements except for arsenic have significant relationships with different soil physiochemical properties and major oxides. In turn, oxides and the physiochemical properties of the soil and its type reduced the bioaccumulation of these elements in wheat grains except for arsenic, as appeared in the present study, that toxic heavy elements do not accumulate in wheat grains. And among the studied elements, arsenic had the highest bioaccumulation rate in wheat grains, because its concentration in soil has been affected by only human activities.

Keywords: Toxic; Agriculture; Soil; Oxides; Bioaccumulation

1. Introduction

Toxic heavy elements are considered one of the serious environmental contaminants (Nagajyoti et al. 2010). The main toxic heavy elements include arsenic, lead, mercury, cadmium, nickel and chromium (Friis, 2012; Tokar et al. 2013), they are toxic even in low concentrations and have the ability to bioaccumulate, this indicates that they may become harmful due to their entry into the food chain (Friis, 2012). The high soil content of heavy elements causes negative impacts on life forms and the environment due to their toxicity (Al-Jaberi et al. 2016). The reason for considering pollution and accumulation of toxic heavy elements as a significant problem is because of their plenty of different sources, toxicity, non-biodegradable characteristics, and tendency to accumulate (Hu et al. 2017). The bio-availability of elements in the soil is influenced by several factors including pH of the soil, the contents of organic matter; carbonates; clay minerals; iron, manganese, aluminum oxides as well as oxidation and reduction conditions (Alloway, 2005). Oxidic conditions may lead to a release of elements

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from organic matter, and they can also be released from carbonate and manganese-iron oxide due to the changes in pH and ionic composition (Al-Hamdani et al. 2016). The study area is constantly exposed to various pollutants by oil and industrial facilities, usage of chemical pesticides and fertilizers for agriculture purposes and from highways. As a result, toxic elements are added to agricultural soil and translocated into cultivated plants. Yaychi region is considered one of the important agricultural areas where various crops of cereals and vegetables are cultivated continuously and consumed by the population. the aim of this study is to identify the extent of toxic heavy elements translocation from agricultural soil to wheat grains, thus their bioaccumulation, and the role of the oxides and soil type and its different physiochemical properties in reducing bioaccumulation of these elements in wheat grains and therefore have knowledge whether these agricultural lands are suitable for planting wheat crop or not.

2. Study Area Characteristics

Yaychi is located in Kirkuk governorate between longitude ($44^{\circ} 20' 39.438''$ E - $44^{\circ} 09' 57.905''$ E), and latitude ($35^{\circ} 33' 21.953''$ N - $35^{\circ} 18' 41.585''$ N) northeast of Iraq (Fig. 1). Tectonically, the study area is located within unstable shelf in the low folded zone which represented by Chamchamal-Erbil subzone (Al-Kadhimi et al., 1996). Structurally, the northeastern part of study area is composed of Kirkuk anticline (Baba Dome) and it is a convex fold with a reverse faulting in the area (Sissakian and Fouad, 2012). On the other hand, stratigraphically, the study area is covered with quaternary deposits, while tertiary deposits (represented by Fatha, Injana, Mukdadyia and Bai Hassan formations) are exposed in the northeast part of the study area within Kirkuk structure (Sissakian and Fouad, 2012).

Fig. 1. Location map of the study area

3. Materials and Methods

Soil and wheat samples were collected in a manner that covers the entire study area and focused on the areas near many sources of pollution. Twenty soil samples were collected using auger for depth of 0-20 cm. The soil samples were dried, all debris like stones (small gravel) and plants residues have been removed, then grinded with ceramic mortar and sieved through 200 mesh sieve and analyzed for its content of toxic heavy elements using modified aqua regia digestion (1:1:1 HNO₃:HCl:H₂O) by ICP-MS in Acme Lab in Vancouver, Canada. Soil properties (Calcium Carbonate CaCO₃, Calcium Sulfate CaSO₄.2H₂O, Electrical Conductivity EC, Organic Matter OM) of these samples were analyzed in Kirkuk Agriculture Directorate Laboratories according to methods described as follows CaCO₃ by Estefan et al. (2013), CaSO₄.2H₂O, EC by Richards (1954) and OM by Walkley (1947). While pH of soil was determined by preparing a suspended solution of calcium chloride (CaCl₂) as described by Whitehead (1973) in the Biochemistry Laboratory, Chemistry Department, Science Faculty, Kirkuk University. Size fraction analysis of soil samples was also performed as described (Carver, 1971; Folk, 1974). On the other hand, eight samples of wheat grain were collected from the same soil sampling sites in order to assess toxic heavy elements translocation, and analyzed for its content of these elements using aqua regia digestion method on the raw material by ICP-MS in Acme Lab in Vancouver, Canada.

4. Results and Discussion

4.1. Soil Physiochemical Properties and Type

Soil physiochemical properties can affect the bioavailability of toxic elements and their mobility in soil, so some of these properties have been studied (Table 1). Soil pH plays an important role in the movement and bioavailability of toxic heavy elements in soil. Between the basic and acidic soil solution, the movement of the toxic elements is less in the first because they are adsorbed on the surface of the basic soil more than the acidic soil. Soil is considered to be ultra-acid, extremely acid, very strongly acid, strongly acid, moderately acid, slightly acid, neutral, slightly alkaline, moderately alkaline, strongly alkaline, very strongly alkaline when the soil pH is < 3.5, 3.5-4.4, 4.5-5.0, 5.1-5.5, 5.6-6.0, 6.1-6.5, 6.6-7.3, 7.4-7.8, 7.9-8.4, 8.5-9.0, >9.0 respectively (Soil Science Division Staff, 2017). The average soil pH of the study area was 8.31 therefore; the soil of the study area is generally considered to be moderately alkaline soil, except for the site Y15 of Dibag Tapa2 village where pH value for this site was 8.50 and considered to be strongly alkaline soil according to Soil Science Division Staff, 2017. Calcium carbonate (CaCO₃) average in the soil of the study area is (31.05%), according to the classification of the calcareous soil of Gundalia, and Savalia (2001) which depend on the calcium carbonate proportion. The soil type of Y1, Y2, Y4, Y10, Y11, Y12, Y16, Y19 sites are highly calcareous soil and Y3, Y5, Y6, Y7, Y8, Y9, Y13, Y14, Y15, Y17, Y18, Y20 sites are strongly calcareous soil. Calcareous soils can be formed either as a result of weathering parent material (limestone) or due to the calcification process (Alloway, 2005). Average concentration of calcium sulfate (CaSO₄.2H₂O) was 0.08% therefore; soil of study area is considered to be non-gypsiferous, except for the site Y14 of Dibag Tapa1 village where calcium sulfate concentration was 1.12%, therefor; soil of this site is considered to be slightly gypsiferous depending on Barzanji (1973). OM can reduce the bioavailability and immobilize of heavy elements by retaining these elements, but increasing the amount of OM in the soil leads to the release of the elements into the soil solution (Sherene, 2010). and OM average in soil of study area was 1.25%. Its low concentrations in the soil of the study area may be due to overgrazing and burning of farmlands (Al-Saady et al., 2016), traditional tillage (Barut and Celik, 2017) and drought climate (Göl, 2017). Salinity of the soil increases mobility of heavy metals (Mitchell et al., 2016). EC average of soil of the study area was 0.55 mmhos/cm and according to (Soil Science Division Staff, 2017) is non saline soil, where soils with electrical conductivity (EC) (<2 mmhos/cm) is a non-saline soil. The results of the size

fraction analysis of soil samples showed that soil of the study area generally constitute of 44% silt, 32% sand, and 24% clay, with a loam texture (USEPA, 1996). The clay percentage was the lowest percentage compared with the other soil parts of the study area. The heavy elements mobility in the soil is greatly influenced by the type of the soil texture, due to its relationship with adsorption surfaces for heavy elements in soil like oxides and clay, as the elements are held in clay soil more than sandy soil (Sherene, 2010).

Table 1. Different soil physiochemical properties of the study area

Samples No.	pH	CaCO ₃ %	CaSO ₄ .2H ₂ O %	OM %	EC mmhos/cm	Sand %	Silt %	Clay %
Y1	8.38	25.80	0.16	1.37	1.15	6	50	44
Y2	8.22	29.88	0.01	1.56	0.26	54	26	20
Y3	8.09	33.04	0.02	1.08	0.24	8	55	37
Y4	8.24	27.44	0.00	2.76	0.34	56	28	16
Y5	8.33	30.96	0.04	0.67	0.44	60	28	12
Y6	8.26	38.44	0.00	0.49	0.27	36	40	24
Y7	8.27	33.44	0.00	1.08	0.36	54	30	16
Y8	8.30	31.00	0.00	0.85	0.20	52	30	18
Y9	8.30	35.64	0.00	0.51	0.25	11	71	18
Y10	8.36	26.36	0.00	0.82	0.18	20	52	28
Y11	8.24	27.24	0.00	1.73	0.31	28	50	22
Y12	8.33	27.68	0.02	1.12	0.69	11	64	25
Y13	8.37	31.48	0.01	1.50	0.72	54	32	14
Y14	8.27	30.64	1.12	1.04	1.49	41	43	16
Y15	8.50	31.12	0.00	1.22	0.51	50	28	22
Y16	8.39	26.64	0.00	1.65	0.60	5	56	39
Y17	8.42	38.40	0.06	1.68	0.81	13	54	33
Y18	8.38	32.60	0.11	1.07	1.05	5	54	41
Y19	8.34	27.48	0.09	1.63	0.88	38	42	20
Y20	8.30	35.72	0.01	1.24	0.36	42	36	22
Average	8.31	31.05	0.08	1.25	0.55	32	44	24

4.2. Toxic Heavy Elements Concentration in Agricultural Soil and Wheat Grain

The concentrations of toxic heavy elements increased in the following order Ni > Cr > Pb > As > Cd > Hg with rates of 107.49, 73.54, 9.20, 6.78, 0.23 and 0.018 mg/kg respectively (Table 2). The rate of nickel was 107.49 mg/kg and its concentration in all studied sites exceeded its rate in earth's crust (56 mg/kg) (Wedepohl, 1995) and Canadian Agricultural Soil Quality Guidelines for Ni (45 mg/kg) (CCME, 2015). While the rate of As and Cd elements was 6.78, 0.23 mg/kg respectively and their concentration exceeded its rate in earth's crust 1.7, 0.1 mg/kg respectively (Wedepohl, 1995). Cr rate was 73.54 mg/kg and its concentration exceeded its rate of the Canadian Agricultural Soil Quality Guidelines (64 mg/kg) (CCME, 1997). The reason of higher contents of Ni, As, Cd, Cr elements could be related to vehicles emissions (De Silva, 2016), oil industries (Ahmed and Gulser, 2019) and fertilizers usage (Biney et al., 1994). In contrast, of Pb and Hg contents (9.20, 0.018 mg/kg respectively) did not exceed any of the earlier criteria. In comparison, toxic heavy metals in wheat grains increased in the following order Cr > Ni > Pb > As > Cd > Hg to 2.11 > 0.53 > 0.29 > 0.26 > 0.005 > 0.0003 mg/kg respectively (Table 3).

Table 2. Concentrations of toxic heavy elements (mg/kg) in agricultural soil

Samples No.	Pb	Ni	As	Cd	Cr	Hg
Y1	11.35	124.5	7.1	0.24	81.5	0.061
Y2	11.79	110.7	7.0	0.29	76.8	0.018
Y3	8.76	108.5	7.6	0.27	76.8	0.019
Y4	9.31	98.6	6.1	0.29	69.3	0.010
Y5	10.00	106.0	6.6	0.17	69.6	0.024
Y6	8.45	95.9	6.6	0.26	74.3	0.011
Y7	8.31	90.5	6.7	0.25	65.2	0.019
Y8	8.37	99.2	7.4	0.23	69.6	0.024
Y9	7.65	93.8	6.3	0.20	66.9	0.010
Y10	9.90	126.5	7.3	0.24	81.2	0.022
Y11	10.07	128.0	7.1	0.24	85.7	0.006
Y12	8.50	99.9	6.4	0.21	66.1	0.013
Y13	8.68	116.3	7.1	0.22	73.7	0.011
Y14	9.01	95.7	7.0	0.15	65.2	0.010
Y15	8.33	95.1	7.4	0.29	73.0	0.018
Y16	9.65	117.9	6.2	0.23	77.9	0.023
Y17	7.90	97.5	6.4	0.27	69.0	0.019
Y18	9.73	123.3	6.2	0.18	77.3	0.016
Y19	9.19	124.8	6.5	0.23	80.6	0.020
Y20	9.09	97.2	6.7	0.25	71.1	0.008
Average	9.20	107.49	6.78	0.23	73.54	0.018
Earth Crust ^a	14.8	56	1.7	0.1	126	0.04
Canadian agricultural soil quality guidelines ^b	70	45 ^c	12	1.4	64	6.6

^a (Wedepohl, 1995) ^b (CCME, 1997) ^c (CCME, 2015)**Table 3.** Concentrations of toxic heavy elements (mg/kg) in wheat grains

Wheat Samples No. / Soil Samples No.	Pb	Ni	As	Cd	Cr	Hg
G1/Y1	0.56	0.5	0.3	0.03	2.3	0.001
G2/Y3	0.60	0.5	0.3	<0.01	2.0	<0.001
G3/Y9	0.16	0.5	0.3	<0.01	2.0	<0.001
G4/Y12	0.17	0.5	0.2	<0.01	2.2	<0.001
G5/Y18	0.14	0.7	0.2	0.01	2.1	<0.001
G6/Y16	0.17	0.7	0.4	<0.01	2.0	0.002
G7/Y17	0.18	0.5	0.2	<0.01	2.1	<0.001
G8/Y14	0.40	0.4	0.2	<0.01	2.2	<0.001
Average	0.29	0.53	0.26	0.005	2.11	0.0003

4.3. Soil Content of Toxic Elements Relationship with Oxides and Soil Physiochemical Properties

Understanding the relationship between toxic heavy elements in soil (Table 2) and some major oxides (Table 4), as well as the physiochemical properties of soil in the study area can help to explain the behavior of these elements in the soil. Therefore, the data were subjected to the statistical analysis of the Pearson correlation coefficient using SPSS 22, Table 5. Positive correlation between Pb-Al₂O₃ (r= 0.753), Pb-Fe₂O₃ (r= 0.720), Pb-MnO (r= 0.521), Ni-Al₂O₃ (r= 0.849) and Ni-Fe₂O₃ (r= 0.906), Ni-MnO (r= 0.626), Cr-Al₂O₃ (r= 0.729) and Cr-Fe₂O₃ (r= 0.787), may indicate to the adsorption of (Pb, Ni, Cr) elements on the surface of these oxides. While a negative correlation between Pb-CaO (r= -0.578), Ni-CaO (r= -0.744), Cr-CaO (r= -0.600), Pb-CaCO₃ (r= -0.586), Ni-CaCO₃ (r= -0.619) and Cr-CaCO₃ (r= -0.462) may indicate substitution of these elements with calcium in calcite in varying proportions (Kabata-Pendias, 2011), then forming the element carbonates. Oxides and clay minerals have a significant role in reducing heavy elements abundance and mobility in the aqueous solution due to their large surface areas, by ion exchange and adsorption mechanisms (Ugwu and Igbokwe, 2019).

Table 4. Concentrations of major oxides (%) in agricultural soil

Sample No.	Al ₂ O ₃	Fe ₂ O ₃	CaO	MnO
Y1	9.56	4.80	16.06	0.10
Y2	9.42	4.78	16.84	0.09
Y3	8.69	4.44	18.93	0.08
Y4	8.89	4.48	17.18	0.09
Y5	9.23	4.61	16.73	0.10
Y6	8.36	4.23	19.38	0.08
Y7	8.07	4.12	20.99	0.08
Y8	8.23	4.27	20.08	0.08
Y9	8.20	4.18	18.98	0.08
Y10	9.58	4.86	17.00	0.09
Y11	9.94	5.01	16.08	0.09
Y12	8.62	4.41	17.52	0.09
Y13	9.19	4.74	16.52	0.10
Y14	9.06	4.41	18.81	0.09
Y15	8.37	4.26	18.74	0.08
Y16	9.26	4.69	16.57	0.09
Y17	8.29	4.23	18.60	0.09
Y18	8.87	4.53	18.44	0.09
Y19	9.47	4.88	15.68	0.10
Y20	8.06	4.13	21.24	0.08

Table 5. Relationship between toxic heavy elements, major oxides, and soil physiochemical properties

	Pb	Ni	As	Cd	Cr	Hg
Al ₂ O ₃	0.753**	0.849**	0.146	-0.148	0.729**	0.269
Fe ₂ O ₃	0.720**	0.906**	0.159	-0.075	0.787**	0.266
CaO	-0.578**	-0.744**	0.067	0.071	-0.600**	-0.291
MnO	0.521*	0.626**	-0.162	-0.330	0.342	0.375
pH	-0.101	0.105	-0.180	-0.112	0.014	0.27
CaCO ₃	-0.586**	-0.619**	-0.131	0.07	-0.462*	-0.364
CaSO ₄ .2H ₂ O	0.027	-0.132	0.086	-0.548*	-0.265	-0.041
OM	0.257	0.212	-0.245	0.453*	0.198	-0.045
EC	0.118	0.179	-0.176	-0.516*	-0.048	0.284
Sand	0.003	-0.353	0.183	0.146	-0.311	-0.267
Silt	-0.191	0.217	-0.257	-0.300	0.127	0.032
Clay	0.264	0.447*	-0.028	0.111	0.485*	0.525*

** Correlation is significant at the 0.01 level (2-tailed), * Correlation is significant at the 0.05 level (2-tailed)

The positive correlation between Cd-OM ($r = 0.453$), indicates the adsorption of cadmium on the surface of organic matter and its binding with immobile forms (Sungur et al. 2014). Moreover, Cd-CaSO₄.2H₂O ($r = -0.548$) and Cd-EC ($r = -0.516$) showed negative correlation. These two relationships may be attributed to the fact that Cd concentration in the soil of study area did not affect by soil salinity, as calcium sulfate (gypsum) is one of the salt types exist in the nature, and (Kadkhodaie et al. 2012) pointed out that the soil salinity increases Cd abundance in soil. The positive correlation between Ni-Clay ($r = 0.447$), Cr-Clay ($r = 0.485$) and Hg-Clay ($r = 0.525$), refers that these three elements are adsorbed on clay surfaces. No correlation was observed between the pH and soil content of toxic heavy elements, which may indicate that the elements availability were not affected by pH, as well as Pearson correlation showed that arsenic was not associated with any of the oxides and soil physiochemical properties, which could indicate that the arsenic available to the wheat for absorption in the study area was not affected by the oxides or the physiochemical properties of the soil.

4.4. Bioaccumulation of Toxic Heavy Elements in Wheat Grain

Wheat was studied to understand the extent of the effectiveness of oxides and different soil physiochemical properties and its type in the retention of toxic heavy elements in the agricultural soil of

the study area and reducing if not preventing their translocation to the plant, thus their bioaccumulation, as it is one of the most planted crops in the region. There are many processes that control heavy elements absorption from the soil by plants like oxidation and reduction reactions, deposition-dissolution and ionic exchange (Bajraktari et al. 2019). Heavy elements translocation and accumulation are influenced by species of the plant, elements bioavailability, soil composition (De Silva, 2016) and its physiochemical properties (Xiao-Rui et al. 2016). The transfer and bioaccumulation of toxic heavy elements from soil to wheat grain was studied using the bioaccumulation factor. Since the bioaccumulation factor (BCF) represents the concentration of toxic elements in plant tissue to the concentration of toxic elements in the soil (Boussen et al. 2013).

$$BCF = C_{\text{plant}} / C_{\text{soil}} \quad (1)$$

When BCF value is ≤ 1 it refers that the heavy elements do not accumulate in the plant; whereas the $BCF > 1$ indicates the accumulation of elements in the plant tissue (Liu et al., 2009). It turns out that the studied toxic heavy elements do not accumulate in wheat grains (Table 6), indicating the weak accumulation of toxic heavy elements in wheat grains despite their high concentrations in the soil. This may be because the bioaccumulation of elements (Pb, Ni, As, Cd, Cr and Hg) in wheat grains is the least compared to other parts of the wheat plant (i.e. leaves, stems and roots) (Xiao-Rui et al., 2016).

Table 6. Bioaccumulation rates of toxic heavy elements in wheat grains

Samples No.	Pb	Ni	As	Cd	Cr	Hg
G1	0.049	0.004	0.042	0.125	0.028	0.016
G2	0.068	0.005	0.039	0.000	0.026	0.000
G3	0.021	0.005	0.048	0.000	0.029	0.000
G4	0.020	0.005	0.031	0.000	0.033	0.000
G5	0.014	0.006	0.032	0.056	0.027	0.000
G6	0.018	0.006	0.065	0.000	0.026	0.087
G7	0.023	0.005	0.031	0.000	0.030	0.000
G8	0.044	0.004	0.029	0.000	0.034	0.000
Average	0.032	0.005	0.039	0.022	0.029	0.012

The bioaccumulation of toxic heavy elements in general is relatively low as in the following order $As > Pb > Cr > Cd > Hg > Ni$ at $0.039 > 0.032 > 0.029 > 0.022 > 0.012 > 0.005$ respectively. However, there is a difference between the bioaccumulation rates of toxic heavy elements, and this may be due to the role of oxides and the physiochemical properties of the soil. It was observed that the bioaccumulation of arsenic is higher than the other studied elements, while it did not have the highest concentration among the studied elements in the soil, possibly due to the fact that the arsenic available to the wheat for absorption in the study area unlike other elements was not affected by any of the oxides and physiochemical properties soil as previously described in the results of the Pearson correlation. Although, the concentration of lead in soil was low in comparison to Cr, In addition to the significant role of $CaCO_3$ and major oxides in the retention of Pb and Cr, beside Cr adsorption on clay surface. However, the bioaccumulation of lead was found to be higher than that of chromium. This may indicate that Pb ability to translocate and accumulate in wheat grains is higher than Cr. While the soil of the study area is contaminated with Cd, the bioaccumulation of Cd in wheat grain was not high, because soil type of study area (inorganic and non-saline soil) helped to reduce Cd bioaccumulation, (Karak et al., 2014) pointed that increasing quantity of OM in the soil could affect the cadmium mobility and toxicity in the soil through forming a mobile organic cadmium compounds. Also (Rinaudo et al., 1988) has reported that cadmium concentration increases with increasing gypsum proportion in soil.

Although, nickel content in the studied soil samples is the highest, and the soil of study area is considered being contaminated with Ni, but its bioaccumulation found to be the lowest compared to the rest of the studied elements. This could refer to the soil physiochemical properties (CaCO_3 and clay content) as well as Fe, Mn, and Al oxides affected Ni availability in the soil more than the other studied elements. The Hg low concentration in soil and its adsorption on clay surfaces as discussed previously caused Hg low bioaccumulation. Mercury content in the soil is affected by clay content, as its content increases with the increase in the percentage of clay, due to clay retaining mercury on its surface (Kongchum et al., 2011). Bioaccumulation of Pb and Cr were higher than Ni in wheat grain, although nickel concentration in soil was the highest, likely because of the stronger adsorption capacity of CaCO_3 as well as Fe, Mn, and Al oxides for Ni than Pb and Cr, which could be noticed from the high correlation values between Ni and this properties and oxides comparing to the Pb and Cr in soil. (Chaney et al. 2008) have mentioned that calcium element in the soil decreases nickel absorption by plants, and (Alloway, 2005) suggested that Ca^{+2} in calcium carbonate could be substitute by other elements. Which means that wheat plant of study area may absorbed the calcium instead of the elements (Ni, Cr and Pb). This may be due to the occurrence of substitution the calcium of the calcium carbonate in the soil of study area with (Ni, Cr and Pb) elements, which led to formation of (Ni, Cr and Pb) carbonate compounds, thus the release calcium into the soil solution.

5. Conclusions

High concentrations of Ni, As, and Cd elements in the studied soil samples showed that the soil is affected by these three elements as a result of human activities (vehicle emissions, oil industries, and fertilizer usage). The soil type of study area is medium alkaline, non-saline, calcareous, non-gypsiferous, inorganic and loam texture according to soil physiochemical properties. It was concluded that soil physiochemical properties and thus its type as well as the oxide content of the soil played an important role in reducing the bioaccumulation and concentration of Pb, Ni, Cd, Cr and Hg elements in wheat grains except for arsenic. As for arsenic, it did not show any relationship with any of the soil physiochemical properties and oxides, indicating that its concentration in soil has been affected by only human activities that exist in the study area, leading to the higher bioaccumulation comparing with the other studied elements. This indicates two things: first, strong influence of oxides, soil type and its physiochemical properties on preventing or minimizing the translocation of Pb, Ni, Cd, Cr and Hg elements into wheat grains which planted in contaminated soil, thus protect and preserve consumer health from being exposed to these toxic elements. Second, since the arsenic content in the soil of the study area was not affected by any of the oxides and the physiochemical properties of the soil, this means that if the concentration of arsenic in the soil was higher than its current concentration, it may cause a serious problem due to arsenic increased bioaccumulation in wheat grains. It became clear that wheat grains grown in the soil of the study area do not pose any potential risks regarding the soil-plant translocation mechanism of Pb, Ni, Cd, Cr and Hg elements. Thus, the studied farmlands of Yaychi area currently are suitable for planting wheat crops regarding the concentration of toxic heavy elements and soil conditions.

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