COMPARISON BETWEEN CHEMICAL AND MINERALOGICAL PROPERTIES OF OAK FOREST AND BARE CULTIVATED SOILS IN IRAQI KURDISTAN REGION*

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ABSTRACT

This study was conducted during 1/7/2016 to 20/12/2018, which aimed to determine chemical and mineralogical properties of oak forest and bare cultivated soils at 6 locations in Iraqi Kurdistan region, the samples were collected from two depths (0 – 30) and (30 – 60) cm. The study included some chemical and physical properties and identification of clay minerals from X-ray diffraction data. Peak height is used as a rough indicator of relative abundance of minerals. In general, the expansion of 14°A to ≈ 17°A in ethylene glycol treatment was not detected because measuring started from 5θ so that's why we cannot differentiated between Chlorite and Semectite in that treatment. The main results indicated that the organic matter, clay content and CEC values in forest soils were higher than their values in bare cultivated soils, swelling chlorite being the dominant mineral in these soils. While the miner clay mineral at that locations were Kaolinite. Mica was identified at all location, while the dominant type of Mica at forest soils was Muscovite which was obtained from 4 Locations, while Mica Biotite was dominant in bare cultivated soils which was obtained from 4 sites.

Keywords: physical and chemical properties, chlorite, clay minerals.

*** Part of PhD dissertation of the first author**

مقارنة بين طريقتي الكيميائية و المادة العضوية في ترب غابات البلوط في اقليم كردستان –العراق

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المستخلص

هدفت الدراسة مقارنة بين طريقتي الكيميائيـة و المادة العضوية في قي ترب غابات البلوط في اقليم كردستان –العراق. تم اخذ خمسة واربعون عينة تربة و اجريت تقدير المادة العضوية باستخدام طريقة كيميائية و طريقة الاحتراق الجاف. اشارت النتائج الى وجود علاقة معنوية ($r=0.88^{**}$) بين طريقتي المدروسة وهذا يعني ان هنالك تعديلا جيدا لتحويل المادة العضوية و طريقة الفقد عند الاحتراق (الجاف) الى الطريقة الكيميائية كماده عضويه.يمكن استعمال المعادلة لتحويل الماده العضوية بالطريقتين في محافظات اربيل وسليمانية ودهوك. هذه المعادلة مهمه جدا من ناحية اقتصادية لتحديد وتحويل الطريقة الجافة الى الرطبة وتم تسجيل كميةالمادة العضوية. وكانت اعلى قيمة للمادة العضوية بالطريقة الجافة هي (97.6,77.9,50.3)جم كجم $^{-1}$ رتبة التربة(MD3,VD4,AD4) بالتتابع.

الكلمات المفتاحية: رتبة التربة، قوام التربة، كربونات الكالسيوم، طريقة الاحتراق.

***Received:17/4/2019, Accepted:24/7/2019**

INTRODUCTION

In arid and semiarid regions many oak species were growing. All of them are slow growing and stunted, there are many species of oak trees and the Valonia oak (*Quercus aegilops L)* is the common native species in Iraqi Kurdistan region. It is found on all kinds of soils but grows best on loamy soil in a dry climate and mountain areas with as little as 400mm rain per year (17). Forest soils in north of Iraq are usually characterized by being shallow with some deep soils in the plains and valleys area. Forests are usually grown on non-covered rocks penetrated with some forest trees roots which lead to weathering of parent materials. So, the characteristics of such soils are highly depending on the nature of the parent material consistent directly (37). The chemistry of clay and humus colloids were limiting soil's chemical properties. The very high specific surface area of colloids gives soil its great ability to hold and release cations (25). Osman (26) mentioned that, most elements are not generally found in pure elemental forms; they are bond in the minerals. There are a variety of primary minerals mostly associated with sand and silt fractions Quartz, Feldspar, Mica, Olivine, Pyroxene, Amphiboles, etc. and secondary minerals associated mostly with clay fraction Kaolinite, Montmorillonite, Vermiculite, Illite, Chloride, Halloysite, etc. Pidwirny (28) mentioned that these interfacial interactions between the lithosphere, hydrosphere, atmosphere, and biosphere profoundly alter both the surface of the solid earth and the chemistry of its fluid envelopes. Weathering also influences a variety of human activities of particular interest here are mineral transformations during weathering which form soil minerals, releasing both essential nutrients such as K^+, Mg^{2+}, and Ca^{2+} and toxic elements such as Al^{3+} into terrestrial ecosystems and subsurface and surface waters (34). Clay minerals may be significant indicators of earth processes. They formed by hypogene processes result from the action of gases, vapours, or solutions that originate below and force their way upward through rocks of the earth's crust (21). Nutrients required for plant growth other than nitrogen and sometimes sulphur is initially supplied by a chemical dissolution of primary minerals in the process known as weathering. vascular plants should accelerated weathering more than activity of any likely pre-existing primitive terrestrial organisms such as algae and lichens, because of the much greater contact area between minerals and the huge mass of fine roots of the higher plants and because of plants much faster growth and internal storage of rock weathering derived cations (9 and 10). Land use change considerably influence on soil quality especially on organic matter and structural stability (13). Soil Texture play a key role in determining many soil chemical properties such as exchange and movement of base cations (22). Increase in large particles in forest soils was a positive correlated with organic matter content, while increase in clay percentage represents a negative correlation with organic matter content (36). The high acidity in forest soils is significantly correlated to the control region and in similar climatic conditions forest soils show a more tendency to be acidic compared to bare cultivated soils (14 and 29). Mishra and Sharma (23) suggested that the forestation with leguminous tree species (oak trees) reduce the soil acidity. Acidity in lower layer was significantly higher than the first depth given the higher accumulation of organic matter in the soil surface layers and an indirect relationship between acidity and organic matter decrease soil pH in the first depth (22). In general the value of Cation exchange capacity in upper layer was higher than those in lower layer; it may be due to the higher organic matter and clay content in upper layers (31). There are numerous investigations about studying chemical and mineralogical properties of forest soils conducted by (4, 24, 31, 8 and 3) but none of them included special type of forest and they didn't covered different topographical locations for these reason this investigation was selected to study the chemical and mineralogical properties of oak forest soils and comparing them to bare cultivated soils from Gara in Dohuk to Sartak in Halabja.

MATERIALS AND METHODS

This investigation was conducted from 1/7/2016 to 20/12/2018. Before soil sampling, several trips were made to identify the representative sites. The trips emphasis done to select the suitable and representative Oak forests and bare cultivated soils on one hand and to cover a wide spectrum of soil properties on the other hand, for this purpose, 6 sites were selected in Kurdistan region starting from Gara in Dohuk to Sartak in Halabja as shown from Table 1. Soil samples were air dried and passed through 2mm sieve. Particle size distribution was performed by hydrometer method according to (11). The pH of saturation extract was measured after equilibrium for 24 hours with pH-meter, according to (19). Soil organic matter percent was obtained using a modified WaKley-Black technique (5). Cation exchange capacity was determined by means of 1*M* (NH_4OAc) solution as described in (Estefan e*t al*., 2013). Soluble Potassium was determined using flame photometer as described by (18). Available potassium was determined using Flame photometer according to method described by (7). Total potassium was determined by digestion 0.1 g of fine soil with 5 ml of Hydrofloric acid HF 48% and 0.5 ml of Perchloric acid ($HClO_4$) 72% by using 30 ml Pt crucible, which heated to 200 - 250ºC according to (19) method as describe by (27). The sample solutions were analyzed for K^+ by flame photometer. Clay minerals was identified by X-Ray diffraction, the soil samples was prepared according to (20).

Table 1. Shows geographical coordinates of the studied locations

Governorate	Location	Latitude	Longitude	Altitude (m)
Duhok	Gara	37°01'40.24''	43°20'04.91''	1193
	Matin	37°04'51.73''	43°15'58.30''	955
	Brifca	36°48'32.89''	43°10'42.19''	778
Halabja	Bakhakon	35°15'43.05''	46°06'34.75''	1143
	Hawar	35°09'51.03''	46°06'27.42''	1134
	Sartak	34°56'25.55''	45°46'43.32''	1195

RESULTS AND DISCUSSION

Properties of studied soils

Inspection of table 2 and 3 reveal that there is a wide variation of soil clay content which ranged from (123.05 to 431.1 g kg^{-1}) for forest soils with the mean of (314.32 g kg^{-1}), the lowest value was obtained at Sartak for a depth of (0 – 30) cm, while the highest value was recorded from Bakhakon for a depth of (0 – 30) cm. In bare soils the highest clay content was awarded at Bakhakon for a depth of (0 – 30) cm which was (422.59 g kg^{-1}), and the lowest value was (144.53 g kg^{-1}) at Sartak for a depth of (0-30) cm, with the mean of (313.8 g kg^{-1}). The silt content for forest site samples ranged from (157.02 to 498.13 g kg^{-1}) for a depth of (0 – 30) cm for Matin and Sartak sites respectively, with the mean of (320.56 g kg^{-1}), while the silt content at bare site samples ranged from (293.39 to 453.67 g kg^{-1}) for a depth of (30 – 60) cm for Bakhakon and Brifca sites respectively with the mean of (346.96 g kg^{-1}). The highest value of sand for forest samples was obtained at Matin site for a depth of (30 – 60) cm which was (508.18 g kg^{-1}), while the lowest value was obtained at Hawar for a depth of (30 – 60) cm which was (216.68 g kg^{-1}), with the mean of (365.12 g kg^{-1}). In bare soils the sand content ranged from the lowest value (202.56 g kg^{-1}) at Hawar site for a depth of (30 – 60) cm, to (541.57 g kg^{-1}) at Sartak for a depth of (30-60) cm with the mean of (339.25 g kg^{-1}). It is appeared from the above results that the mean values for clay and sand content were higher at forest soil than their content at bare soils, while silt content at bare soils was higher than forest soils. Regarding the soil pH, it was recognized that the soil pH ranged from (7.16) for Sartak forest site to (7.52) at Matin Forest site, and (7.01) at Sartak site and (7.56) at Gara bare cultivated soil. It is appeared from these results, that the soil pH of soils is slightly alkaline (7.40 – 7.80) (33). Nearly all of the forest samples soils classified as a high soil organic matter content (O.M $\geq$ 12.93 g kg^{-1}), and Bare cultivated samples classified as a medium soil organic matter (8.62 > O.M < 12.93 g kg^{-1}) according to scheme proposed by (7) in general the amount of organic matter decreased with an increase in soil depth, similar results was obtained by (12, 32, 31 and 8). It can be observed from Table 2 and 3 that the cation exchange capacity CEC value was varied from (21.27 to 55.79) $Cmolc.kg^{-1}$ for forest samples and (16.05 to 34.07) $Cmolc.kg^{-1}$ for bare cultivated samples. The lowest value for both forest and bare cultivated sites was obtained at Sartak for a depth of (30 – 60) and (0 – 30) cm respectively, and the highest value was obtained at Gara and Matin for a depth of (0 – 30) cm depth. In general, the obtained results indicated that upper layer for all studied soils exhibit high value of CEC in comparison with lower layer, except of Brifca at both Forest and bare site, and Sartak bare site which were recorded the lowest value, similar results was obtained by (8).

Table 2. Some physical and chemical properties of investigated forest soils

#	Sites	Depth	Clay	Silt $g\ kg^{-1}$	Sand	pH	O.M	CEC
1	Gara	0 - 30	265.28	285.68	449.04	7.38	26.63	55.79
		30 - 60	265.36	234.74	499.90	7.41	13.54	43.91
2	Matin	0 - 30	359.63	157.02	483.35	7.52	39.12	34.82
		30 - 60	258.59	233.24	508.18	7.48	20.24	34.59
3	Brifca	0 - 30	382.35	372.36	245.29	7.46	27.39	27.40
		30 - 60	314.57	456.63	228.81	7.49	20.59	33.08
10	Bakhakon	0 - 30	431.10	263.73	305.17	7.39	27.93	34.06
		30 - 60	411.11	258.85	330.05	7.45	21.78	33.38
11	Hawar	0 - 30	376.01	334.84	289.15	7.46	21.72	32.93
		30 - 60	403.82	379.51	216.68	7.48	26.54	32.55
12	Sartak	0 - 30	123.05	498.13	378.82	7.21	12.23	25.44
		30 - 60	180.98	372.02	447.00	7.16	6.58	21.27
	Mean	0 - 30	322.90	318.63	358.47	7.40	25.84	35.07
	Mean	30 - 60	305.74	322.50	371.77	7.41	18.21	33.13
Total Mean			314.32	320.56	365.12	7.41	22.02	34.10

Table 3. Some physical and chemical Properties of bare cultivated soils

#	Sites	Depth (cm)	Clay $g\ kg^{-1}$	Silt	Sand	pH	O.M $g\ kg^{-1}$	CEC $Cmolc\ kg^{-1}$
1	Gara	0 - 30	308.31	357.33	334.36	7.51	12.26	28.39
		30 - 60	256.14	322.13	421.73	7.56	7.20	24.53
2	Matin	0 - 30	415.49	316.51	268.00	7.19	19.21	34.07
		30 - 60	368.94	337.43	293.64	7.38	7.51	32.78
3	Brifca	0 - 30	293.16	392.15	314.69	7.52	12.26	24.22
		30 - 60	186.51	453.67	359.83	7.50	6.13	32.17
10	Bakhakon	0 - 30	422.59	317.15	260.26	7.39	18.86	33.38
		30 - 60	397.90	293.39	308.72	7.47	12.32	32.25
11	Hawar	0 - 30	419.48	324.41	256.12	7.26	16.93	31.57
		30 - 60	383.16	414.28	202.56	7.38	9.39	30.36
12	Sartak	0 - 30	169.35	321.16	509.49	7.11	7.90	16.05
		30 - 60	144.53	313.90	541.57	7.01	4.31	16.20
	Mean	0 - 30	338.06	338.12	323.82	7.33	14.57	27.95
	Mean	30 - 60	289.53	355.80	354.68	7.38	7.81	28.05
Total Mean			313.80	346.96	339.25	7.36	11.19	28.00

This may be due to differing in soil chemical and physical properties especially $CaCO_3$, organic matter and clay content. The statistical analysis also explain the positive role of organic matter and clay content in increasing soil CEC, the significant correlation coefficient was recorded between CEC, organic matter and clay content for bare cultivated soil with correlation coefficient values of (r = 0.91** and 0.91 **) respectively as shown from Figure 1. On the other hand the non-significant positive correlation coefficient was recorded between CEC, Organic matter and clay content for forest soils with (r = 0.51 and 0.14) respectively as shown from Figure 2. The increase in CEC value in upper layer can be described by the high amount of organic matter and clay contents. Decomposition of organic matter and weathering of primary minerals are possible sources of exchangeable cations (35). The positive correlation between clay content and soil CEC may be due to increase in clay causes increase in negative charge because clay particles regards as a source of negative charge. At the same time increase in organic matter content in both soils caused increase in CEC value these may be due to high functional group content of organic matter, which are regarding as a source for negative charges.

Potassium forms in studied soils

As shows from Table 4 the highest value of total potassium at forest sites was (61.96 Cmolc kg^{-1}) which was recorded at Brifca site for a depth of (30 – 60), while the lowest value was (18.22 Cmolc kg^{-1}) recorded at Hawar for a depth of (30 – 60) cm. Exchangeable potassium was obtained by subtracting soluble from available potassium, the highest values of exchangeable and available potassium at forest soils were recorded at Bakhakon for a depth of (0 – 30) which were equal to (23.09 and 23.27 Cmolc kg^{-1}) respectively and the lowest value of them were recorded at Sartak for a depth of (30 – 60) cm, which were equal to (1.01 and 1.04 Cmolc kg^{-1}) respectively.The highest amount of soluble K^+ at forest sites was recorded at both depths at Hawar location which was equal to (0.27 Cmolc kg^{-1}) and the lowest value was recorded at Sartak and Brifca site at depth of (30 – 60) which was (0.03 Cmolc kg^{-1}).

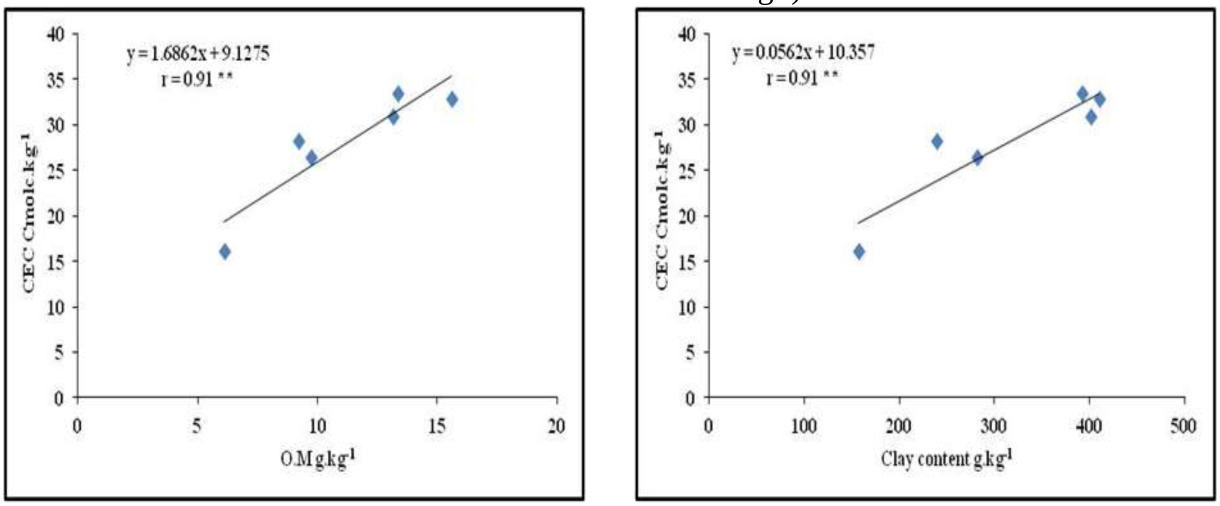

Figure 1. Correlation between CEC, organic matter and clay content in bare cultivated soils

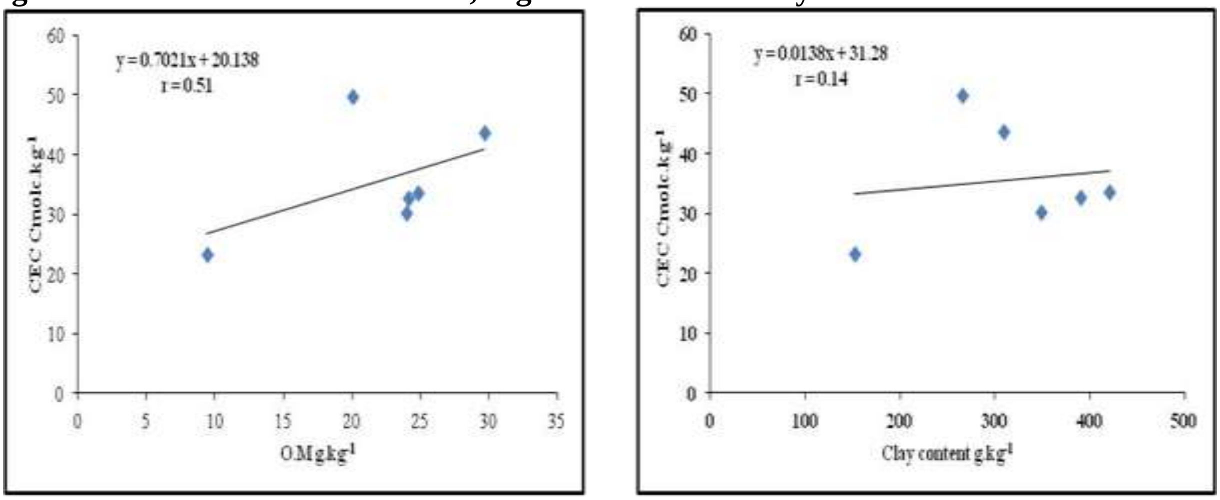

Figure 2. Correlation between CEC, organic matter and clay content in forest soils

Table 4. Forms of potassium for forest soil sites

#	Depth (cm)	Potassium forms in Cmolc kg^{-1} soil: Total	Exchangeable	Available	Soluble	Mineral + Non Exchangeable
Gara	0 - 30	50.73	11.2	11.27	0.07	39.46
	30 - 60	46.38	9.86	9.91	0.05	36.47
Matin	0 - 30	44.43	9.44	9.55	0.11	34.88
	30 - 60	56.62	5.39	5.44	0.05	51.18
Brifca	0 - 30	40.98	8.01	8.13	0.12	32.85
	30 - 60	61.96	5.46	5.49	0.03	56.47
Bakhakon	0 - 30	28.22	23.09	23.27	0.18	4.95
	30 - 60	33.36	16.9	17.06	0.15	16.3
Hawar	0 - 30	27.36	15.91	16.18	0.27	11.18
	30 - 60	18.22	12.58	12.85	0.27	5.37
Sartak	0 - 30	52.94	2.72	2.78	0.06	50.16
	30 - 60	55.67	1.01	1.04	0.03	54.63
Mean	0 - 30	40.60	11.00	11.12	0.13	29.48
Mean	30 - 60	46.07	6.72	6.80	0.08	39.27
Total Mean		43.33	8.86	8.96	0.10	34.37

The highest amount of minerals and non-exchangeable potassium was recorded at Brifca forest site, which was equal to (56.47 Cmolc kg^{-1}) for a depth of (30 – 60) cm, while the lowest value of mineral and non-exchangeable potassium recorded at Bakhakon for a depth of (0 – 30) which was equal to (4.95 Cmolc kg^{-1}). Table 5 explains the potassium forms in bare cultivated soils, the highest value of total potassium was recorded at Brifca for a depth of (0 – 30) cm which equal to (56.06 Cmolc kg^{-1}), and the lowest value (39.07 Cmolc kg^{-1}) was recorded at Hawar site for a depth of (0 – 30) cm. The highest value of exchangeable and available potassium (98.25 and 8.31 Cmolc kg^{-1}) were recorded at Matin site for a depth of (0 – 30) respectively, while the lowest values (1.01 and 1.04 Cmolc kg^{-1}) were obtained at Sartak site for the depth of (30 – 60) cm respectively. The highest amount of soluble K^+ at was recorded for a depths of (0 – 30) cm at Hawar location which was equal to (0.12 Cmolc kg^{-1}) and the lowest value was recorded at Gara, site for depth of (30 – 60) which was (0.02 Cmolc kg^{-1}). These results disagree with those obtained by (6) this may be due to the difference between chemical and geological and climatically condition of desert soils and forest soils.

Table 5. Forms of potassium for bare cultivated soil sites

#	Depth (cm)	Potassium forms in Cmolc kg^{-1} soil: Total	Exchangeable	Available	Soluble	Mineral + non Exchangeable
Gara	0 - 30	49.08	3.56	3.59	0.03	45.49
	30 - 60	49.62	2.00	2.02	0.02	47.6
Matin	0 - 30	52.47	8.25	8.31	0.06	44.16
	30 - 60	46.36	5.90	5.95	0.05	40.41
Brifca	0 - 30	56.06	4.53	4.56	0.03	51.5
	30 - 60	47.88	2.79	2.83	0.05	45.05
Bakhakon	0 - 30	41.89	4.16	4.27	0.10	37.62
	30 - 60	49.02	2.36	2.39	0.03	46.63
Hawar	0 - 30	39.07	6.95	7.08	0.12	31.99
	30 - 60	47.70	3.43	3.49	0.06	44.21
Sartak	0 - 30	51.23	1.63	1.67	0.04	49.56
	30 - 60	49.01	1.01	1.04	0.03	47.97
Mean	0 - 30	46.90	5.43	5.50	0.07	41.40
Mean	30 - 60	46.60	3.74	3.78	0.04	42.82
Total Mean		46.75	4.58	4.64	0.05	42.11

The highest amount of mineral and non exchangeable potassium was recorded at Brifca site, which was equal to (51.5 Cmolc kg^{-1}) at a depth of (0 – 30) cm, while the lowest value of mineral and non-exchangeable potassium recorded at Bardanga (0 – 30) which was equal to (31.99 Cmolc kg^{-1}). The positive significant correlation was recorded between organic matter and available potassium in both forest and bare cultivated soil, with the correlation coefficient values of (r = 0.50** and 0.73**) respectively as shown from Figure 3 and 4. This may be due to slowly release of potassium and decomposition of organic matter (1).

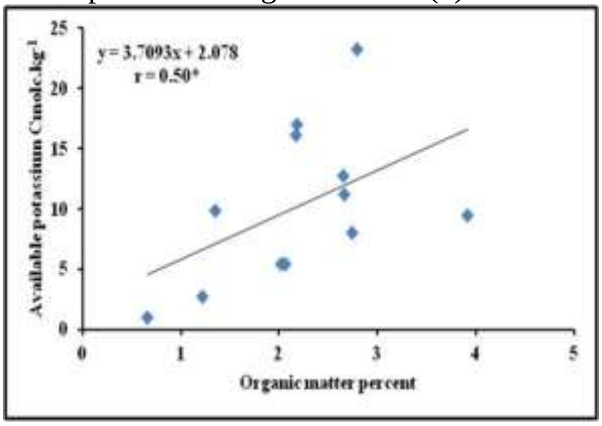

Figure 3. Shows the correlation coefficient between available potassium and organic matter content at forest soils

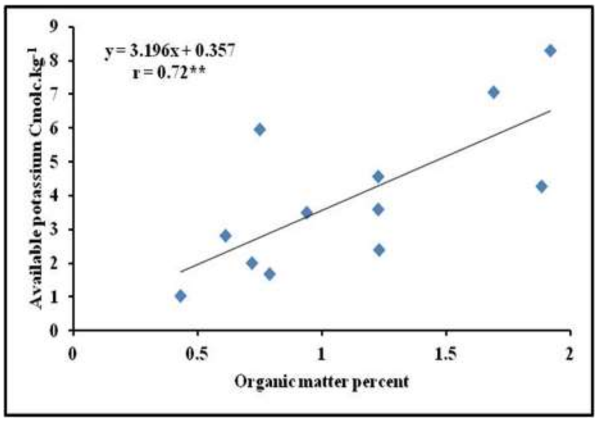

Figure 4. Shows the correlation coefficient between available potassium and organic matter content at bare cultivated soils

Identification of clay minerals in studied soil

The identification of dominant clay minerals depended on the peak height as shown from Figures 5 and 6, In general, the swelling chlorite being the dominant mineral in the forest soils. The occurring of swelling chlorite in forest soils is due to deposition of hydroxyl materials (Fe-Hydroxides or Mg-hydroxides) within the interlayer spaces of expansible layer silicate such as Semectite, because an increasing of such elements in surface horizon of forest soils could be due to positive differences between element input fluxes, principally by mass flow, minerals weathering, and organic matter mineralization and element output fluxes (30).Dixon et al., 1977 have observed that more frequently inter layering is greatest in the surface horizon and decrease with depth, this depend on the amount and types of complexes between organic acids such as fulvic and humic with elements in soil solution as we know that the studied soils , were calcareous soils and the Ca^{+2} and Mg^{+2} are dominant in soil solution and these elements are ready to make a complexes with these organic acids, and all divalent elements complexes with humic acids are non soluble, this is the first stage of hydroxyl inter layer formation inside the inter layers of 2:1 expandable minerals. Numerous studies have been done on these complexes in Kurdistan region well support this hypothesis such as (24 and 31). This complexes are non soluble and non leachable so they were dominant in surface horizon and decrease with depth this findings are in agreement with (15). Mica minerals are identified by 10ºA reflection and it remains the same in all treatments. The distinction between Di-octahedral mica (Muscovite) and Tri-octahedral mica (Biotite) is based on the second order of d-spacing of mica.The second order for muscovite (5ºA) in Mg-saturated air-dry treatment is high and stronger than second order of Biotite. Kaolinite is characterized by 7ºA reflection and remain the same in Mg-saturation air dry, ethylene glycol-saturation, K-saturation air dry, and K-saturation 350ºC, while it disappears in K-saturation 550ºC. Swelling chlorite was dominant at 4 locations of forest soils as shown in table (6) it means that 66.67% of the forest soil samples recorded the highest swelling Chlorite content. The dominant swelling chlorite was observed from most of the studied locations except of Gara and Brifca sites. The dominant clay minerals were real chlorite and mica-biotite respectively. It means that 66.67%, 16.67% and 16.67 % of the dominant minerals were swelling chlorite, real Chlorite and mica-biotite respectively. This results disagree with those recorded by (2) due to the difference between the soil applied in this study with the soils applied in our study in additional to difference in starting point of theta.

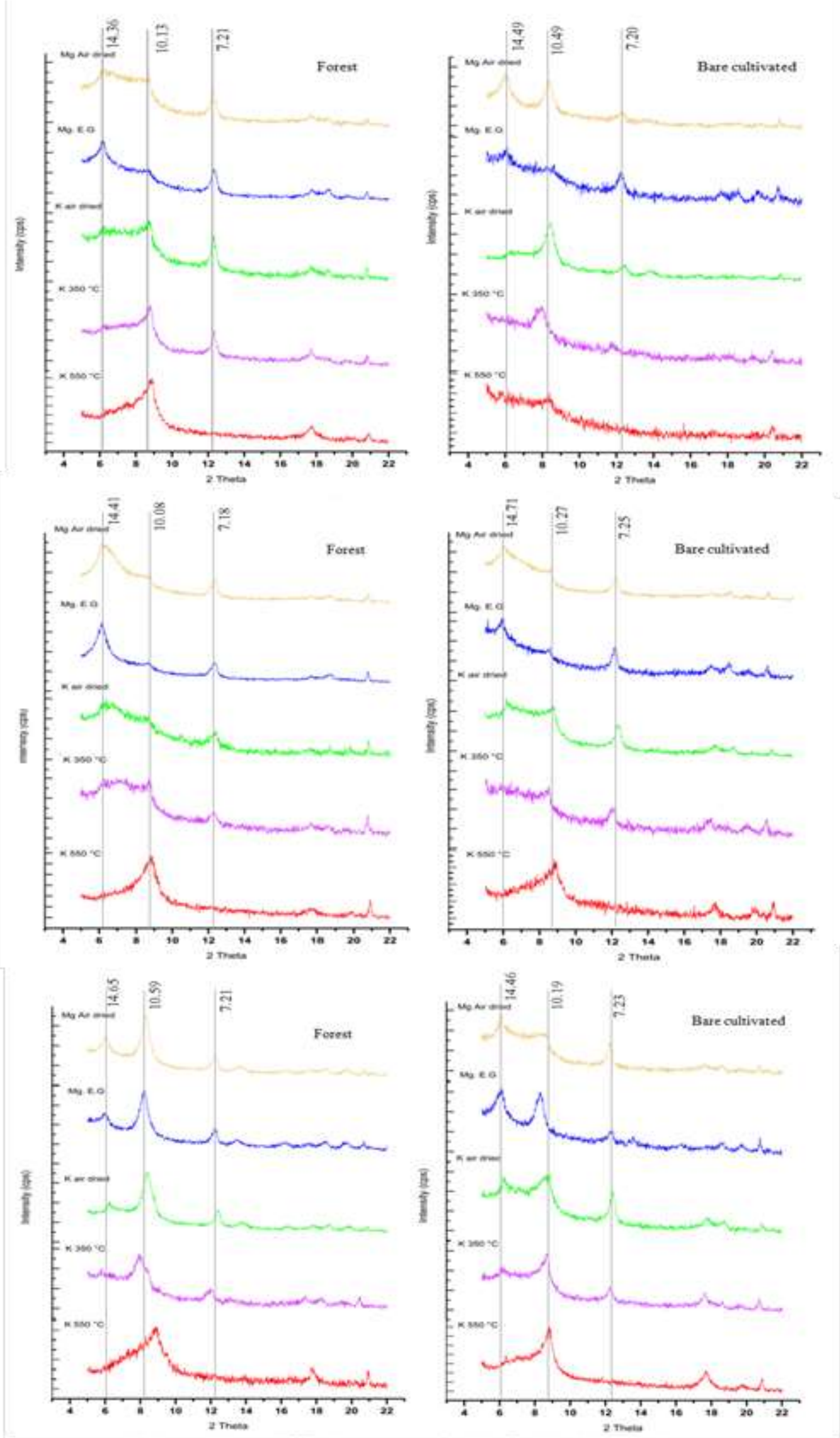

Figure 5 X-Ray diffraction patterns for Gara, Matin and Brifca sites respectively

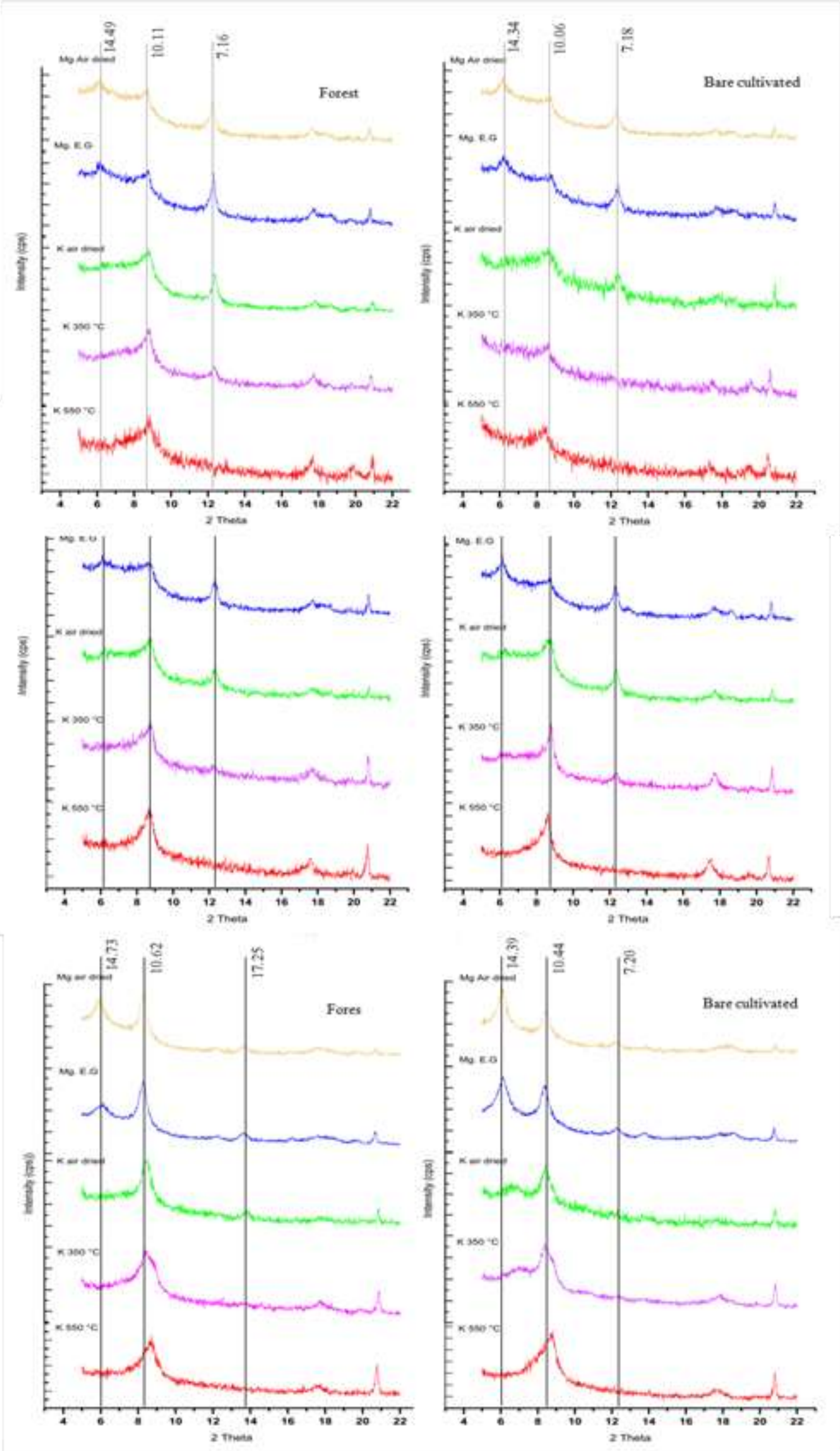

Figure 6 X-Ray diffraction patterns for Bakhakon, Hawar and Sartak sites respectively

Table 6. Shows the observed clay minerals in forest soil samples

#	Site	S. Chlorite	R. Chlorite	Mica	Kaolinite	Non-clay minerals
1	**Gara**	——	++++	+++ **Muscovite**	++	**Quartz K-Feldspar**
2	**Matin**	++++	——	+++ **Biotite**	++	**Quartz K-Feldspar**
3	**Brifca**	+++	——	++++ **Biotite**	++	**Quartz K-Feldspar**
10	**Bakhakon**	++++	——	+++ **Muscovite**	++	**Quartz Dolomite K-Feldspar**
11	**Hawar**	++++	——	+++ **Muscovite**	++	**Quartz K-Feldspar**
12	**Sartak**	++++	——	+++ **Muscovite**	++	**Quartz Dolomite K-Feldspar**

Note [Dominant (++++) 50 – 90%, Major (+++) 20 – 50 %, Minor (++) 5 – 20 % and Trace (+) < 5%] and Non-clay minerals detected

The miner clay mineral for the forest soils was kaolinite; the dominant type of mica was muscovite which was obtained from 6 sites, while biotite obtained from 5 sites. It appears that muscovite was recorded from 66.67% of forest sites while biotite recorded at 33.33% of forest sites. Non-clay minerals such as (Quartz and K-Feldspar) were recorded from all studied forest soils, while the dolomite was recorded from 2 forest soils which were equal to 33.33% of the studied forest soils. As shown from Table 7 real chlorite was denoted at 3 sites of bare cultivated soils, it means that 50% of the bare cultivated soil samples recorded the highest real chlorite content, and swelling chloride recorder from 3 sites of bare cultivated soils it means that 50% of bare cultivated soil recorded swelling chloride as a dominant clay mineral, Non-clay minerals such as (Quartz and K-Feldspar) were recorded from all studied forest soils, while the Dolomite was recorded from 1 bare cultivated soil which was equal to 16.67% of the bare cultivated soils.

Table 7. Shows the observed clay minerals in bare cultivated soil samples

#	Site	S. Chlorite	R. Chlorite	Mica	Kaolinite	Non-clay minerals
1	**Gara**	——	++++	+++ **Biotite**	++	**Quartz K-Feldspar**
2	**Matin**	++++	——	+++ **Biotite**	++	**Quartz K-Feldspar**
3	**Brifca**	——	++++	+++ **Biotite**	++	**Quartz K-Feldspar**
10	**Bakhakon**	++++	——	+++ **Muscovite**	++	**Quartz Dolomite K-Feldspar**
11	**Hawar**	——	++++	+++ **Muscovite**	++	**Quartz K-Feldspar**
12	**Sartak**	++++	——	+++ **Biotite**	++	**Quartz K-Feldspar**

Note [Dominant (++++) 50 – 90%, Major (+++) 20 – 50 %, Minor (++) 5 – 20 % and Trace (+) < 5%] and Non-clay minerals detected

Depending on the obtained results the conclusion was as follow:

The ratio between mean of organic matter content of forest soil and bare cultivated soils was (1.96). The CEC in forest soils have higher than CEC value than bare cultivated soil, with the ratio of (1.22). The ratio between mean of total and available potassium in forest and bare cultivated soils were (0.92, and 1.93) respectively. The series for dominant clay minerals of forest soils was as follow (swelling chlorite > real chlorite > mica biotite) which were recorded at (66.67%, 16.67% and 16.67%) of the studied forest sites respectively, while real and swelling chlorite in bare cultivated soils recorded at (50% and 50%) of the studied sites. Smectite group was not identified in this investigation because the starting point was (5 theta).

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