COMPARISON BETWEEN ORGANIC MATTER CONTENT OF MAIN SOIL ORDERS IN KURDISTAN REGION USING TWO DIFFERENT METHODS.*

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ABSTRACT
This study was conducted to compare between two methods of soil organic matter determination for main soil orders in Kurdistan region/Iraq, for this purpose forty-five soil samples were taken then the organic matter was determined using chemical (Walkley-Black (wet) method and loss-on-ignition method (dry) combustion method. The results indicated the significant correlation (r = 0.88**) between the studied methods It means there is good adjustment to convert organic matter by loss-on-ignition method (dry) to Walkley-Black (wet) method organic matter by this linear equation (organic matter by loss-on-ignition =1.651* Walkley-Black method organic matter +2.1877) this equation can be used to convert organic matter by two methods for Mollisols(M), Vertisols(V) and Aridisols(A) in Hawler(H), Sulaimani(S) and Duhok(D) governorates, this equation is very important and economic to determine and convert dry method to wet method, the amount of organic matter for M, V, A was recorded the highest value (49.5, 24.8, 20 gkg⁻¹) respectively for Mollisols, Vertisols, and Aridisols at Hawler (H), Sulaimani (S), and Duhok(D) respectively for (DM5, SV4, DA1) in Duhok Mollisols, Sulaimani Vertisols and Duhok Aridisol respectively for walk- black (wet) method, the highest value for dry method organic matter in Mollisols, Vertisols, Aridisols was recorded (97.6, 77.9, 50.3 g kg⁻¹) for soil orders (MD3, VD4, AD4) respectively.

مقارنة بين طريقتين تقدير المادة العضوية في الترب الرئيسية في اقليم كردستان باستعمال طريقتين مختلفتين

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المستخلص
أجريت هذه الدراسة للمقارنة بين طريقتين لتقدير المادة العضوية في رتبة التربة الرئيسية في إقليم كردستان / العراق ، لهذا الغرض تم أخذ خمسة وأربعين عينة تربة ثم تم تحديد المادة العضوية باستخدام طريقة كيميائية ((Walkley–Black wet)). وطريقة الاحتراق (الجاف): أشارت النتائج إلى وجود علاقة معنوية (0.88 = r **) بين الطرق المدروسة وهذا يعني أن هناك تعديلًا جيدًا لتحويل المادة العضوية عن طريق طريقة الفقد عند الاحتراق (الجاف) إلى طريقة –Walkley (Black wet)) مادة عضوية بهذه المعادلة الخطية (المادة العضوية عن طريق الفقد أثناء الاحتراق = 1.651 * Walkley–Black الطريقة العضوية +2.1877) يمكن استخدام هذه المعادلة لتحويل المادة العضوية بطريقتين لـل (Mollisols (M) و (Vertisols (V) و (Aridisols (A) في محافظات هولير (H) و السليماني (S) و دهوك (D)، هذه المعادلة مهمة جدًا من الناحية الاقتصادية لتحديد وتحويل الطريقة الجافة إلى الطريقة الرطبة وتم تسجيل كمية المواد العضوية بالنسبة لـ M، V، A حيث تم تسجيل أعلى القيمة (49.5، 24.8، 20) جم كجم ⁻¹ على التوالي M، V، A ، لـ (DM5، SV4، DA1) على التوالي لطريقة ((Walkley–Black (wet))، أعلى قيمة للمواد العضوية بالطريقة الجافة في M، V، A تم تسجيل (97.6 ، 77.9 ، 50.3) جم كجم ⁻¹ رتبة التربة (MD3، VD4، AD4) على التوالي.

INTRODUCTION

Iraqi soils illustration different degrees of development according to the dominant local conditions mainly climatic and geological conditions. The results of the morphological, physical and chemical soil properties indicated to the presence of five soil orders including Aridisols, Entisols, Inceptisols, Mollisols, and Vertisols. Each order shows some variations within the common properties reflecting the effect of the dominant local conditions mainly, climatic and type of parent materials (17). These orders arranged according to their percentage from the total Iraqi area as follow: Aridisols (62.2 %), Entisols (16.2%), Inceptisols (12.6%), Mollisols (3.8%) and Vertisols (1.2 %) respectively in Kurdistan regain the dominant orders are Mollisols, Aridisols and Vertisols. When plant residues are returned to the soil, various organic compounds undergo decomposition. Decomposition is a biological process that includes the physical breakdown and biochemical transformation of complex organic molecules of dead material into simpler organic and inorganic molecules (3) Organic matter plays important roles in improving soil physical, chemical, and biological properties. It is considered as a very important parameter of soil fertility and productivity. It provides nutrients to the soil, improves water holding capacity and helps the soil to maintain better aeration and soil quality for seed germination and plant root development (3,21,30). Soil organic matter is considered to be a key influence of soil quality because of its effect on the chemical, physical, and biological properties and processes in soils. Conversely, it is not sensitive to short-term changes of soil quality with different soil or crop management practices due to high background levels and natural soil variability, it has been suggested by (14,5). Soil organic matter plays an important role in nutrient cycling in tropical ecosystems as well as important for the maintenance of soil structure and fertility (20,24,25,26). Soil organic matter encompasses a diversity of organic compounds with decomposition rates which vary continuously due to the complex interactions of biological, chemical and physical processes in soils (11). It is well

known the importance of soil organic matter for soil quality and plant growth. Thus, several methods have been proposed for its measurement (15,27) and several papers discussed the most common ones. The establishment of the relationship among different methods of organic carbon determination is important for soil carbon (12,22). There are little or no studies about the correlation between the methods of organic matter determination for this reason this study was selected to explain the statistical relationship between them. The objective of this study the correlation between soil organic matter content in Kurdistan region using two different methods in different dominant soil orders (Mollisols(M), Vertisols(V) and Aridisols(A)) in Hawler(H), Sulaimani(S) and Duhok(D) in Kurdistan region.

MATERIALS AND METHODS

Three dominant of (soil orders) were collected from Hawler, Sulaimani and Duhok governorates fifteen samples in each order were taken from the soil surface (0-30) cm depth to determine the equation to convert organic matter by Walkley–Black method to organic matter by on-ignition method (dry method) or Versa. Forty-five soil samples were taken on November, 2016 from the soil surface (0-30) cm depth for the dominant soil orders (Mollisols, Aridisol and Vertisols) in Hawler, Sulaimani and Duhok governorates, fifteen samples were taken in each governorate (5 samples per soil order) were air-dried, thoroughly mixed, and sieved using 2mm sieve for soil physical and chemical analysis. The soil analysis included Electrical Conductivity (EC) depending on (23), calcium carbonate ($CaCO_3$) depending on., (7), Moisture content according to (10), and field capacity (FC) and wilting point (W.P) were determined according to the models prepared by (8) Particle size distribution was determined by hydrometer method as mentioned by (10). using sodium hexametaphosphate (Calgon) as the dispersing agent. Soil pH of the saturated extract was measured with pH-meter; model 332 JENWAY, as mentioned by (16).Soil organic matter calculated as the loss-on-ignition method reported by (29). The parameters measured were determined, and the analysis

was carried out at the soil and water department laboratories, in Agriculture College, at Salahaddin University. Three orders Kurdistan regain soil samples, including Mollisols, Vertisols, Aridisols illustrated in (Table 1)

RESULTS AND DISCUSSION

Table 1 illustrates some physic-chemical properties of the studied soils such as soil texture, water content, field capacity, saturation past, calcium carbonate, pH, and electrical conductivity for dominate orders in Kurdistan region Table 1 shows the physic-chemical properties of for Mollisols, Vertisols, and Aridisols in Hawler, Sulaimani, and Duhok, respectively. The results of the numerical simulation indicate that the soil texture for Mollisols, Hawler and Sulaimani were silty loam the amount of particle size distribution for (sand, silt, and clay) were (230, 560, 200) g kg^{-1} and (114.1, 455.9, 430) g kg^{-1} in Hawler and Sulaimani respectively, whereas in Duhok was silty clay, the sand, silt, and clay were (176.2, 396.3, 427.5) g kg^{-1}. As well as the soil texture of Vertisols in Hawler, Sulaimani and Duhok were silty clay, and amount of sand, silt, and clay were (452.4, 71.9, 475.7) g kg^{-1}, (43.2, 400.5, 556.3) g kg^{-1} and (35, 455.8, 509.2) g kg^{-1} respectively, while the soil texture for Aridisols in Hawler and Duhok were clay loam with particle size distribution of (220.2,509.6, 270.2) g kg^{-1} and (221.1, 413.6, 365.3) g kg^{-1} for sand, silt, clay respectively, but for Sulaimani was silty clay loam the amount of sand silt and clay were (143.7, 541.8, 314.5) g kg^{-1} for sand, silt and clay, respectively, results showed that the increase of clay percentage cause increasing in water content as mentioned by (6) Percentage water content (WC), field capacity, (FC), wilting point (W.P), saturation past (SP), calcium carbonate (CaCO$_3$ g kg^{-1}), pH, and electrical conductivity (EC dSm^{-1}) were (5.05, 21.25, 11.59, 39.52, 300, 7.394, 0.36 dSm^{-1}) respectively for Hawler Mollisols, while for Sulaimani Mollisols were (6.0, 30.35, 19.62, 56.45, 230, 7.308, 0.54 dSm^{-1}) was recorded respectively on the other hand. Duhok Mollisols were (4.86, 30.25, 19.53, 56.27, 214, 7.536, 0.48 dSm^{-1}) respectively, so Hawler Vertisols were (4.24, 32.17, 21.22, 59.83, 300, 7.474, 0.4 dSm^{-1}) respectively,

Sulaimani Vertisols were (4.71, 35.37, 24.04, 65.78, 268, 7.464, and 0.29 dSm^{-1}) respectively. Duhok Vertisols were (9.20, 33.50, 22.39, 62.30, 240, 7.472, and 0.36 dSm^{-1}). Hawler Aridisols were (2.34, 24.01, 14.03, 44.65, 488, 7.45, and 0.5 dSm^{-1}) respectively. Sulaimani Aridisols were (3.78, 25.76, 15.58, 47.92, 460, 7.472, and 0.52 dSm^{-1}) respectively. Duhok Aridisols were (2.89, 27.78, 17.35, 51.67, 590, 7.492, and 0.4 dSm^{-1}) respectively. (21,18) said that the soil organic matter has an important effect on the physicochemical status. Increase the amount of organic matter in the soil improve the physical and chemical properties (3,9,19). The relation between the two methods was significantly reported by (22,29) It has been suggested that soil organic matter is considered to be a key influence of soil quality because of its role on chemical, physical, and biological properties and processes in soils The results indicated that there was a significant correlation between two methods using in the determination of organic matter with the correlation coefficient value of (r=0.8819**) (organic matter by loss-on-ignition method =1.651* Walkley-Black method organic matter + 2.1877) y = organic matter by muffle method, X= Walkley-Black method organic matter this equation can be used for convert organic matter by two methods in Mollisols, Vertisols, and Aridisols for Hawler, Sulaimani, and Duhok, in another hand this equation is very important and economic to determine and convert organic matter by the dry method to wet method shown in Figure 1 The figure provides information about the correlation between two methods Walkley-Black method and loss-on-ignition method for determining organic matter Mollisols, Vertisols, and Aridisols in Kurdistan region. This figure shows a significant correlation (r=0.8819**) between two methods (Walkley-black) loss-ignition) used in determining organic matter in this soils, as well as the Paired Samples Statistics, are significant for Mollisols, Vertisols, and Aridisols in each order, the highest value for organic matter was recorded in Duhok Mollisols (49.5 g kg^{-1}) for wet method (Walkley-Black) while the lowest value (38.3 g kg^{-1}) was recorded in Hawler Mollisols

(HM2), as well as the highest value (97.6 g kg^{-1}) for muffle method (dry method) was also in Duhok Mollisols (DM3), whereas the lowest value (80.9 g kg^{-1}) found in Sulaimani Mollisols (SM1). The highest value was recorded for organic matter in Sulaimani Vertisols (SV4) was (24.8 g kg^{-1}) for wet method Walkley-Black, while the highest value for the dry method was recorded in (DV4) was (77.9 g kg^{-1}), where the lowest value (20.4 g kg^{-1}) for Vertisols was recorded in Duhok Vertisols for wet method Walkley-Black, as well as the highest value for muffle method (dry method) in Duhok Vertisols (DV3) was (96.1 g kg^{-1}), so the lowest value (5.32%) was recorded in (HV3) in Hawler Vertisols for dry method. The highest value was recorded for organic matter in Duhok Aridisols (DV1) was (20. g kg^{-1}) in (DA1) for wet method Walkley-Black, while the lowest value in Sulaimani Aridisols (SA5) was (12.9 g kg^{-1}) for wet method Walkley-Black, as well

as the highest value for muffle method was (50.3 g kg^{-1}) Duhok Aridisols in (AD4) for dry method, whereas the lowest value was recorded in Sulaimani Aridisols (SA2) was (26.3 g kg^{-1}) in (SA2). All results were shown in table (2) the amount of calcium carbonate was recorded in Aridisols was (590 g kg^{-1}) in Duhok, while the lowest value for organic matter in Aridisols Sulaimani was (12.9) for chemical method and (26.3) for dry method, pH values were around (8) in most of the soils due to the high calcium carbonate content. Total organic carbon contents were generally low because of the semiarid climatological characteristics by low rainfall and high temperatures according to (2), soil organic matter is a very important source of nutrient (11) the impact of feeding different particle sizes of $CaCO_3$ on weight grain and feed conversions of broilers has not been studied extensively. (4) all results illustrated in the table (2).

Figure(1) correlation between Walkley-Black and loss-on-ignition method for determine organic matter in dominat soil orders (Mollisols, Vertisol, Aridisol) in Hawler, Sulaimany and Duhok .
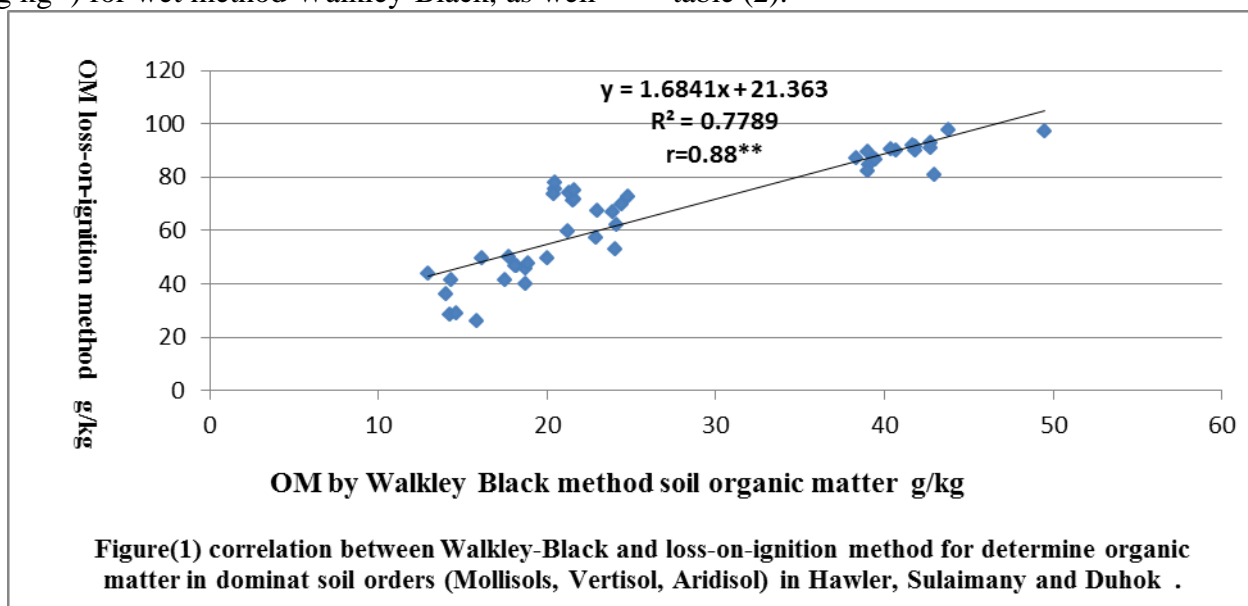
Figure 1. correlation between Walkley-Black and loss-on-ignition method for determine organic matter in dominat soil orders (Mollisols, Vertisol, Aridisol) in Hawler, Sulaimany and Duhok

Table 1 Mean for some chemical and physical properties for dominant soil orders Mollisols, Vertisols, Aridisol in Hawler, Sulaimani and Duhok.

Treatment	Particle Size Distribution g kg^{-1}			WC%	FC	W P	SP	CaCO$_3$	pH	EC
						%		g kg^{-1}		dS m^{-1}
Hawler	Sand	230	Silty loam	5.05	21.25	11.59	39.52	300	7.394	0.36
Mollisols	Silt	560								
	Clay	200								
Sulaimany	Sand	114.1	Silty loam	6.00	30.35	19.62	56.45	230	7.308	0.54
Mollisols	Silt	455.9								
	Clay	430								
Duhok	Sand	176.2	Silty clay	4.86	30.25	19.53	56.27	210	7.536	0.48
Mollisols	Silt	396.3								
	Clay	427.5								
Hawler	Sand	452.4	Silty clay	4.24	32.17	21.22	59.83	300	7.474	0.41
Vertisols	Silt	71.9								
	Clay	475.7								
Sulaimani	Sand	43.2	Silty clay	4.71	35.37	24.04	65.78	268	7.464	0.29
Vertisols	Silt	400.5								
	Clay	556.3								
Duhok	Sand	35.0	Silty clay	9.20	33.50	22.39	62.30	240	7.472	0.36
Vertisols	Silt	455.8								
	Clay	509.2								
Hawler	Sand	220.2	Clay loam	2.34	24.01	14.03	44.65	488	7.45	0.5
Aridisol	Silt	509.6								
	Clay	270.2								
Sulaimani	Sand	143.7	Silty clay loam	3.78	25.76	15.58	47.92	460	7.472	0.53
Aridisol	Silt	541.8								
	Clay	314.5								
Duhok	Sand	221.1	Clay loam	2.89	27.78	17.35	51.67	590	7.492	0.4
Aridisol	Silt	413.6								
	Clay	365.3								

Table 2. The soil organic matter content of the studied soil samples using Walkley-Black and muffle methods for determine organic matter in Hawler, Sulaimani, Duhok, for two different methods

Soil sample			Organic matter g kg^{-1}	
Location	No.samples	Walkley-Black (wet)	loss-on-ignition method (Dry)	
Hawler Mollisols	1	39	89.6	
	2	38.3	87.3	
	3	39.1	84.8	
	4	39.5	86.8	
	5	39	82.4	
Sulaimani Mollisols	1	43	80.9	
	2	41.8	91.6	
	3	40.7	90.1	
	4	41.8	90	
	5	41.7	91.8	
Duhok Mollisols	1	42.7	90.7	
	2	40.4	90.6	
	3	43.8	97.6	
	4	42.7	92.7	
	5	49.5	97.1	
Hawler Vertisols	1	21.2	59.8	
	2	24.1	62.3	
	3	24	53.2	
	4	22.9	57.4	
	5	23.9	67.1	
Sulaimani Vertisols	1	23	67.6	
	2	24.4	69.6	
	3	21.5	71.1	
	4	24.8	72.7	
	5	21.6	71.5	
Duhok Vertisols	1	20.5	75.4	
	2	21.3	74.2	
	3	20.4	73.6	
	4	20.5	77.9	
	5	21.6	74.9	
Hawler Aridisol	1	18.7	46	
	2	16.1	49.5	
	3	17.5	41.5	
	4	18.2	46.6	
	5	18.7	40.2	
Sulaimani Aridisol	1	14.2	28.6	
	2	15.8	26.3	
	3	14	36.3	
	4	14.6	28.9	
	5	12.9	44	
Duhok Aridisol	1	20	49.6	
	2	18.9	47.8	
	3	14.3	41.6	
	4	17.7	50.3	
	5	18.1	46.9	

CONCLUSION

The results of determining the organic matter in the main soil orders Mollisols, Vertisols and Aridisols (M, V, A) in Hawler, Sulaimani, and Duhok for Kurdistan region using wet and dry methods was recorded the significant correlation coefficient between them (r=0.882). The regression equation between the studied methods the analysis shows that correlation between soil organic matter

content for soil orders in Kurdistan region using two different methods was a significant with correlation coefficient value of (r=0.882), and determine the amount of organic matter to three dominant orders in the surface (0-30 cm), also determine the equation for estimate organic matter in three orders convert organic by the wet method to dry method and versa by linear equation. The best for determination of the organic matter is the wet method cause more accuracy. Result illustrated that recommended to determine the organic matter by this equation (organic matter loss-on-ignition method =1.651* organic matter(Walkley-Black method) + 2.1877) this is the economic method to determine the organic matter by wet or dry

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