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VARIATION OF DEHIDROGENASE ENZYME ACTIVITY AND DIFFERENT PEDOGENETIC DEVELOPMENT ON WEATHERED BASALTIC TOPOSEQUENCES

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Abstract

The aim of this study is to examine the changes in dehydrogenase enzyme activity in different pedological development soils formed on the same parent material, but with different slopes, land cover and land use under semihumid climatic conditions. It was carried out on the soil formed on the basaltic parent material in different topographical positions within the Dağköy area of Engiz district, which is located at the south of the Samsun-Bafra Highway. In this study, dehydrogenase enzyme activity was assessed in order to reveal the biological properties of the soil of the study area and it was investigated the dehydrogenase enzyme activity in terms of soil biological property. For this aim, six soil profiles formed on weathered basaltic parent material and located on toposequence of north-south transect were described according to genetic horizon and classified as Lithic Ustorthent, Vertic Haplustept, Typic Haplustept and Typic Haplustert. It was determined that the dehydrogenase changed between 0.073-1.170 µg TPF in soils taken from each profile. In addition, when the statistical relationship between dehydrogenase enzyme activity and different profiles, land use, and elevation along the north-south transect was investigated different profiles and different elevation were found to be important at % 1 level of effect on dehydrogenase enzyme activity in the soil. Also the effect of different land use patterns were found to be important at % 5 level on the activity of dehydrogenase enzyme in the soil.

Keywords: Sugar beet head and leaves, Pellet, Digestibility, Molasses, Urea, Relative feed value

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1. Introduction

Soil microorganisms actively participate in many processes such as mineralization of plant and animal wastes added to soils and biochemical transformation of plant nutrients and also have important effects on soil fertility (Alexander 1977). For this reason, soil fertility is

not only related to the physical conditions and the level of nutrients of the soil, but also the intensity of biological events.

The studies until today reveal that the quality of the soil, the level of fertility and measures to be taken in terms of plant nutrition and the issues related with physical, chemical, biochemical, microbiological, mineralogical, zoological and plant physiology of soil should be considered together (Schinner, 1986). Determination of the biological properties of soils is based on the principle of measuring the activities of microorganisms together with the number and distribution of microorganisms in the soil (Gök and Onaç, 1995). The food cycle in the soil involves biochemical, chemical and physicochemical reactions and many biochemical events through Soil organisms, plant roots and soil enzymes originating from microorganisms are carried out (Tabatabai 1982). In this respect, while investigating the microbiological characteristics of soils, the products formed as a result of microbial activity and enzymes secreted during activity are also measured besides of the number and distributions of microorganisms in the soil (Müller, 1965). Dehydrogenase activity, one of the enzymes used in determining the biological properties of soils, is an intracellular enzyme (Trevors, 1984) found in living microbial cells in the soil and it is an indicator used in the assessment of microbial activity in the soil (Garcia et al. 1994). Thus, dehydrogenase activity is a marker of biological redox systems and is used as a measure of the density of microbial metabolism in the soil (Okur, 1997).

The aim of this study is to examine the changes dehydrogenase enzyme activity in different soils developed on the weathered basaltic toposequence. Soils formed on the same parent material on the other hand, they founded on different physographical units and land cover-land uses under semihumid climatic conditions within the Dağköy area of Engiz district, which is located at the south of the Samsun-Bafra Highway. Therefore, this paper presents also effects of pedogenesis development, topographic changing, elevation, variation of land cover and land use on dehydrogenase enzyme activity.

2. Material and Method

2.1. General Definition of the Research Field

This study was carried out in the south eastern part of the Samsun-Bafra Plain located in the Kızılırmak Delta in the central Black Sea Region of Turkey (Figure. 1). The study area is located approximately 20 km west of the Samsun provincial centre (4594000-4598000 N, 751000-758000 E, UTM/WGS 84 m).

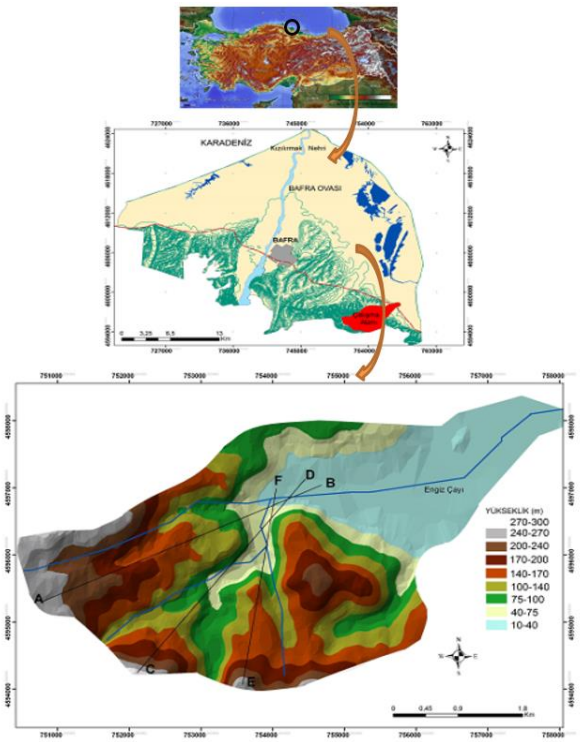

Figure 1. Location map of the study area and cross section with elevation.

The Engiz Brook plays a major role in the formation and development of the landscape. Considered, in the soils formed on the basalt parent material there are pastureland and dry farming lands.In addition, only small part of the study area has been covered by forest land. Some forest land was also degraded due to misuse applications. The current climate in the region is semi-humid. The coldest month of the year is February in the study area (5.6 ºC) whereas, the hottest months are July and August (22.6 ºC). The mean annual temperature, rainfall and evaporation are 13.6ºC, 764.3 mm and 726.7 mm, respectively.

The profile pits lacation were determined by the preliminary field excursion and office works with base data evaluation such as geological, topographical and land use land cover maps after that filed work using the GPS tool in order to determine profile coordinates in the study area, profile pits were excavated defined points in field. Soil samples were taken from each horizon of profiles and brought to the laboratory. After pre-treatment process of soil samples, physical, chemical and biological analyses were performed. Morphological studies were carried out in the field using Soil Survey Staff (1993).

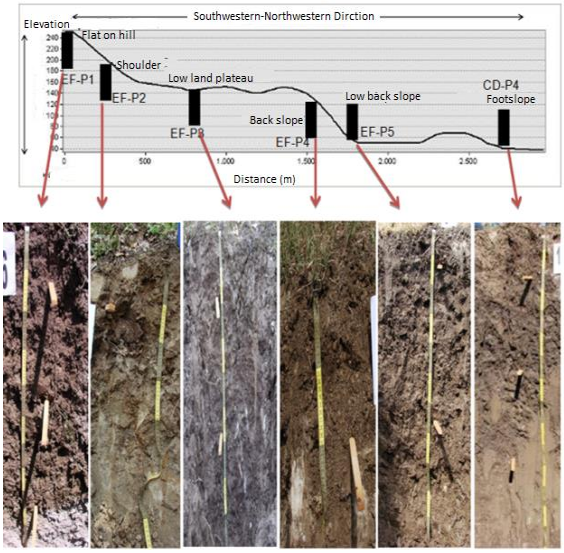

Figure 2. Transect of the four different soil profiles on the same parent material but different topographic positions

2.2. Physical, Chemical and Biological Analyzes

Texture: in disturbed soil samples (Bouyoucos 1951); Cation exchange capacity: using sodium acetate (NaOAc) adjusted to pH 8.2 and 1 N ammonium acetate (NH4OAc) (Rhoades, 1986), Exchangeable cations (Na and K): using ammonium acetate (NH4OAc) adjusted to pH 8.2 (Rhoades, 1986), Ca + Mg was determined by the difference between cation exchange capacity and total exchangeable sodium and potassium. Lime; using Scheibler calcimetry in the determination of free carbonates (Soil Survey Staff, 1993), Soil reaction (pH); Using pH meter in saturation mud (Soil Survey Labrotory, 1992 and 2004), Electrical conductivity; (Soil Survey Labrotory, 1992 and 2004) using a condactivometer instrument in saturation mud, Organic matter was done according to Walkley-Black method by Jackson's modified (Jackson 1958).

The dehydrogenase enzyme activity of the soils taken from the profiles was determined by Pepper et al. (1995). For this purpose, glucose and 3% TTC (2, 3, 5-triphenyltetrazolium chloride) solution were added to the soil sample and incubated for 24 hours at 25 °C. TPF (triphenylformazan) formed at the end of incubation was extracted with methanol and the resulting red color intensity was determined on a spectrophotometer at 485 nm versus the standard TPF series. Each analysis was made in 3 parallels and the findings were expressed in µg TPF g-1 dry soil.

2.3. Statistical Analysis

SPSS 17.0 package program was used to determine the relationship between dehydrogenase enzyme activity and different profiles, land use and elevation in the soil samples of the study area.

3. Results and Discussion

3.1. Physical, Chemical Properties and Classification of Soils in the Study Area

Classification, physiographic position, land use-land cover, elevation, physical and chemical analysis results of different soils (Soil Taxonomy, 1999), located in different topographical positions in the North-South direction are given in Table 1. Vertic Haplustept and Typic Haplustept have deep soils due to their formation on gentle slope lands. Their textures are heavy and clay changes between %54.4 and %61.9, %47.9 and %61.9 on the surface soil and the subsurface horizons, respectively. On the other hand, Lithic Ustorthent located on the slope lands has clay content changes between %22.0 and %32.5. The content of organic matter varies between %1.88 and %3.53 in the surface layers of the Vertic Haplustept and Typic Haplustept soils, but this ratios decrease with increasing depth. In Lithic Ustorthent soil, organic matter values change between %1.54 and %3.37. All soil has low contents of lime in the genetic horizons and slightly alkaline reaction. There is no salinity problem in the soils.

Profiles coded as EF-P4 and EF-P2 were characterized as young soils because they do not have a sub-surface diagnostic horizon and were classified in the Entisol order. These soils on sloping lands have particularly shallow soil depth resulted from covered with low vegetation and misapplication farming practices. In this case, these soils do not have enough pedogenetic processes due to exposure to the resulting erosion. Therefore, there are usually no diagnostic horizons except for a lithic contact in a depth of 50 cm below the surface and ochric epipedone on the surface of these soils. These soils were classified under the Ustorthent and Lithic Ustorthent subordinate due to the moisture regime in the orthent subordinate due to their location on the slope land. On the other hand, due to the fact that profiles coded as EF-P5, EF-P3, EF-P1 and CD-P4 located on the low slope topographical positions such as footslope, low land platuea and falt on hill have more advanced soil formation than the Entisol with the diagnostic horizon (cambic-Bw) and slicensides (Bss). These profiles were classified in Inceptisol order except for CD-P4 that was classified as Vertisol due to slicenside formation. The result is that the soil moisture regime is ustic Ustept subordinate and Haplustept were placed in large group. EF-P5 and EF-P1 were classified as Vertic Haplustept due to their vertical properties on the surface like cruct features and also EF-P3 is classified as Typic Haplustept due to their large group properties. In the soil of CD-P4 profile, the amount of swelling clays is too much (along the profile %50 or more), it has cracks extending from the surface in the dry seasons and are placed in the Vertisol order due to the appearance of sliding surfaces in the profile. Due to the ustic moisture regime, it has been placed in the ustert subordinate and

in the large group of haplustert and Typic Haplustert subgroup due to the fact that all the properties of the large group are carried.

Table 1. Classification of the study area soils, physiographic position, land use-land cover, height, physical and chemical analysis results.

Horizon	Depth (cm)	pH	EC dS.m^{-1}	Lime %	Organic Matter %	Exchangeable Cations (cmol.kg^{-1})			Texture %			
						Na^+	K^+	$Ca^{++}+Mg^{++}$	Clay	Silty	Sand	Class
CD-P4/ Typic Haplustert/ Low footslope/ Dry Agriculture / 20 m												
Ap	0-23	7.50	0.17	0.20	1.65	0.22	1.67	40.19	56.2	23.1	20.7	C
Bss1	23-65	7.30	0.44	0.98	1.26	0.25	1.47	39.64	62.6	12.8	24.5	C
Bss2	65-106	8.25	0.17	1.10	1.09	1.33	1.41	37.59	68.4	15.8	15.8	C
C	106 -146	8.14	0.11	2.67	0.14	1.35	1.40	37.03	78.4	2.8	18.8	C
EF-P5 / Vertic Haplustept / Low backslope / Dry Agriculture/ 50 m												
Ap	0-15	8.28	0.26	0.79	2.21	0.36	0.36	42.97	58.3	20.0	21.7	C
Bw	15-66	8.12	0.18	1.26	0.67	0.47	0.32	42.58	61.9	25.6	12.5	C
2Cr	66-106	8.20	0.25	1.75	0.55	1.02	0.26	26.49	37.3	34.8	27.9	CL
EF-P4 / Lithic Ustorthent / Backslope/ Dry Agriculture/ 135 m												
A	0-19	7.89	0.40	0.39	3.37	0.16	0.49	40.02	32.5	18.6	48.9	SCL
R	19-32	-	-	-	-	-	-	-	-	-	-	-
EF-P3 / Typic Haplustept / Alçak Plato Düzlüğü / Forest /160 m												
A	0-18	7.06	0.44	1.08	1.88	0.24	0.32	46.71	54.4	22.6	23.1	C
Bw	18-57	7.31	0.42	1.02	0.06	0.34	0.09	50.11	61.1	17.7	21.2	C
Cr	57-87	7.01	0.51	0.39	0.57	0.58	0.09	39.87	57.5	22.6	19.9	C
EF-P2 / Lithic Ustorthent / Shoulder / Degraded Forest / 190 m												
A	0-11	6.74	0.35	0.09	1.54	0.35	0.43	27.92	22.0	21.8	56.2	SL
Cr	11-65	7.01	0.20	0.29	0.87	0.54	0.12	17.00	14.6	9.3	76.1	LS
EF-P1 / Vertic Haplustept / Flat on hill / Pasture / 251 m												
A	0-12	7.14	0.55	0.69	3.53	0.29	0.58	48.85	61.9	23.6	14.5	C
Bw1	12-41	7.70	0.54	0.98	1.78	0.27	0.31	43.98	49.9	27.7	12.5	C
Bw2	41-84	7.92	0.11	0.98	1.41	0.64	0.29	51.62	47.9	32.3	19.8	C
2Ck	84-105	7.94	0.38	6.37	1.29	0.63	0.09	43.74	40.0	40.8	19.1	C

EC= electrical conductivity, OM= organic matter, C= clay, Si= silty, S= sand

3.2. Biological Properties of Soils in the Study Area

The determined dehydrogenase activity in the soil is an intracellular enzyme has been frequently used in the assessment of the microbiological activity of that soil and it shows the total amount of oxidative activity of soil microflora (Skujins 1973; Trevors 1984; Kızılkaya and Aşkın, 2006; Aşkın and Kızılkaya, 2009). Analyzes performed to determine the dehydrogenase enzyme activity of the soils taken from the profiles were carried out in 3 replicates and the results of this analysis are given in Table 2.

As a result of dehydrogenase analysis of soil samples taken from each horizon of the profiles, it was determined that the dehydrosine activity that decreased with the soil depths increase were generally lowered in the soil. Dehydrogenase activity is an indicator particularly used in the evaluation of aerobic microorganisms. It is therefore an expected result that high dehydrogenase activity was determined in the surface soil layers due to dominant aerobic conditions. Similarly, Lorenz and Kandeler (2004), Dengiz et al. (2007), Kızılkaya et al. (2007 and 2010), Marinari and Antisari (2010), Antisari et al. (2010), Babu et al. (2010) have also found that topsoil has higher microbial activity.

3.3. Relationships between Profile, Land Use, Elevation and Dehydrogenase Enzyme Activity

The results of the biological analysis considered within this study were evaluated statistically using three parameters which are soil profiles, land use-lan cover and the elevation. Results were presented in Table 3.

Table 2. Concentrations of dehydrogenase enzyme activity characteristics of soil samples taken from the profiles

Horizon	Depth (cm)	Dehydrogenase Activity (µg TPF g^{-1})
CD-P4/ Typic Haplustert/ Low footslope/ Dry Agriculture / 20 m		
Ap	0-23	1.010
Bss1	23-65	1.170
EF-P5 / Vertic Haplustept / Low backslope / Dry Agriculture/ 50 m		
Ap	0-15	0.534
Bw	15-66	0.701
EF-P4 / Lithic Ustorthent / Backslope/ Dry Agriculture/ 135 m		
A	0-19	0.360
EF-P3 / Typic Haplustept / Alçak Plato Düzlüğü / Forest /160 m		
A	0-18	0.819
Bw	18-57	0.073
EF-P2 / Lithic Ustorthent / Shoulder / Degraded Forest / 190 m		
A	0-11	0.147
EF-P1 / Vertic Haplustept / Flat on hill / Pasture / 251 m		
A	0-12	0.840
Bw	12-41	0.332

Table 3. Changes in dehydrogenase enzyme activity depending on the profile, elevation and land use of soils taken from the profiles located on the north-south direction

Profiles	Mean + SE	Elevation (m)	Mean + SE	Land Use	Mean + SE
CD-P4	1.01±0.168a	25.00	310.85±8.694a	Dry Agriculture	0.72±0.094a
EF-P5	0.61±0.044ab	50.00	176.27±14.360ab	Degraded forest	0.58±0.114ab
EF-P4	0.36±0.009bc	135.00	88.42±6.714b	Pasture	0.34±0.117b
EF-P2	0.14±0.011c	160.00	193.29±85.496ab	Significant	0.048
EF-P1	0.58±0.114abc	190.00	170.87±6.835ab		
EF-P3	0.45±0.165bc	251.00	194.75±53.277ab		
Significant	0.006	Significant	0.045		

SE= standard error

According to the ANOVA test result, different profiles and different elevation along the North-South direction were found to be important at %1 level of the effect on dehidrogenase enzyme activity from biological properties of soil (P = 0.006 <0.01). According to the DUNCAN test, it was determined that the highest dehydrogenase enzyme activity along the toposequence is in profile coded as CD-P4 and the lowest dehydrogenase enzyme activity is in profile coded as EF-P2. In terms of height, it was determined that the highest dehydrogenase enzyme activity was 25 m high and the lowest dehydrogenase enzyme activity was 190 m high. It was found that the different land use patterns throughout the EF line were significant at 5% level of the effect on dehydrogenase enzyme activity in the soil (P = 0.048 <0.05). It has been determined that the highest dehydrogenase enzyme activity is in dry agriculture areas and the lowest dehydrogenase enzyme activity is in degraded forest soil.

4. Conclusion

All profiles were defined according to the horizon principle and classified as Lithic Ustorthent, Vertic Haplustep, Typic Haplustept and Typic Haplustert. When the land is examined in terms of the topographic features, it can be said that where the slope is less or low, the developing period of the soil is more advanced level than the places with more slopes due to soil transportation by means of erosion. As a result of the statistical analysis, it was found that different profiles and different elevation along the North-South direction within the basin were significant at %1 level of effect on dehidrogenase enzyme activity from biological properties of soil (P = 0.006<0.01). Different land use

forms were found to be significant at %5 level of the effect on dehydrogenase enzyme activity in the soil (P = 0.048 <0.05). In this case, in order to increase procutive ability and to conserve for sustainability of soil, it is necessary not only to take some measurements which can be successful implemented, but also to know and investigate all properties soil in terms of physical, chemical, pedological as well as biological variations. Improving the biological properties as well as the physical and chemical properties in reaching the highest yield power of the soil, which constitutes the main source of plant and animal nutrients, has great importance. For this reason, it is necessary to concentrate on biologic activities of the soils, that is, applications to increase the natural microbial population and avoid of applications to reduce biological activity. Therefore, the determination of the microbiological and biochemical characteristics of soils with extensive and detailed microbiological studies has a very large importance for the sustainability of agricultural soils.

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