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Comparison of Some Chemical Properties of Amik, Gavur and Golbasi Lakes Soil's

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Abstract

In this study, were carried out the chemical and total elemental analyses of the wetlands, Amik, Gavur and Golbasi Lakes. Amik Lake has a higher level of degradation and mineralization than the other two lakes. Therefore, the high pH and salt value of the plain soil caused the proportions of calcium carbonate and active crime in the soil to increase, the organic matter level and the altitude to be low. The salinity of the soil is less in the Golbasi Lakes. It is related to geological location and land use as it is related to less degradation of area land. Gavur Lake caused more soil organic matter content to remain under water due to inadequate drainage conditions. The presence of limestone and serpentine as a dominant cation of convertible calcium and magnesium in the Eastern Mediterranean Region, the material transported by the surface waters of the rains falling to the region was considered as the main factor in increasing the concentrations of calcium and magnesium in the lake areas. Golbasi Lake has lower sodium adsorption rate values than the soil of Gavur and Amik Lake soil, it can be said that the degradation of the soil is less and it is the result of the effect of the parent material in the region. In the results of the chemical analysis of three wetlands, Al_2O_3 and SiO_2 were hight found to be insoluble and resistant oxides, elements such as CaO, MgO and Na_2O are soluble and mobile elements, it was obtained as a result of this study that the soil is at high levels.

Keywords: Eastern Mediterranean, wetland, soil, chemical property

INTRODUCTION

Wetland, being a part of nature and natural events, was forced to undergo various changes through several interventions over time. The changes in the ecosystem brought about due to artificial interventions have considerably increased in the 20th century and wetland has been drained to attain new cultivated areas not only in Turkey but also in other countries (Finlayson & Davidson, 1996; Özesmi & Özesmi, 1997). Deterioration of wetland is encountered almost anywhere in the world. Changes in the hydrologic conditions being the foremost reason, the reasons of deterioration are listed as urbanization, marinas, industrialization, agricultural activities, silviculture and timber manufacture, peat supply and atmospheric accumulation (Altunbaş & Sarı, 2011).

Due to overirrigation, in areas, such as Çukurova, Gediz, Söke and Amik plain, the quality of soil has decreased, the rate of salinisation and fatal illnesses has increased and the fertilization has dropped. While the rising temperature and vaporization of the wetland speed up the rate of the deterioration of the organic substances in these areas, it also causes the rainfall which is an important source for wetland to decline (Gülsaçan, 2008).

Reviewing the studies on the chemical properties of the soil, it was found that the content of organic properties were different between the old lake soil of the Kestel Lake and Golhisar Lake. The content of organic properties of the soil of the Kestel Lake was noted as 8.2% and that of the Golhisar Lake was found to be 74.1%. These values were compared with the values above the average of Turkey. The lime content of the Kestel Lake was found to be 22%, pH value of 8.3, and that of the Golhisar Lake was found to be 6.5%, pH value of 4.7. The analysis of properties, such as texture, structure, lime, organic matter and pH, before and after the deterioration of wetland showed a change in soil properties, and that these areas are insufficient in terms of agricultural activities (Altunbas, 2005). It was indicated that the soil salinity occurred with the increase of the Ca, Na, K and Mg cations and the value of EC. Furthermore, a positive relationship was found between the Na and pH and Na and SAR values in this study (Horneck et al, 2007). A study on the soil of the Van Castle wetland determined that the pH value of the soil was neutral and that the rate of salinity was within the limits (Kılıç et al, 2004). According to the results of the chemical results on the soil profiles in the Muratbagi village, Şarkikaraağaç province, Isparta which is located in the region of lakes, the amount of SiO_2 declined with the decrease of depth, and consequently this caused a decline in dissolution. In addition, the amount of CaO increased, and the rise in the amount of $CaCO_3$ in the soil was presented as an evidence (Senol, 2012).

As indicated in the above given review of literature, the wetland of our country and the world was claimed of having a high importance and the chemical properties of the soil area were investigated. In the present study the total chemical properties of the wetland of Amik, Gavur and Golbasi Lakes, which are among the most significant wetland regions in the East Mediterranean Region, and the relationship among them was investigated.

MATERIALS and METHODS

Being among the most important wetland areas in Turkey, the Amik Lake in the Hatay province, the Gavur Lake in the Kahramanmaras province and the Golbasi Lake in the province of Adiyaman were chosen for the area of study. The plain of Amik is positioned in the Asi basin which is on the 35°47’ and 36°24’ east meridian, and 35°48’ and 36°37’ north latitude (Kılıç et al. 2004). Being the second area of study, Gavur Lake is located in the deepest pit of the Saglik plain on the 37°18’ north latitude and 36°51’ east meridian (Korkmaz, 2005). Chosen as the third are of study, the Golbasi Lakes (İnekli Lake, Azaplı Lake, Golbasi Lake), which are the most important wetland areas between the Mediterranean and South-east Anatolian Region are located in the Golbasi depression in the East Anatolian fault zone (Master plan). A total of 89 soil horizon was determined in the areas of study.

The soil samples gathered based on the principles of Jackson (1962) were dried in a laboratory environment and were sifted through a 2 mm sieve. The saturation percentage (Demiralay, 1993), soil reaction (Thomas, 1996), electrical conductivity (Tüzüner, 1990), total of lime (Gülçur, 1974), active lime (Yaloon, 1957) were conducted based on the method of wet decomposition, and organic matter [20], useful phosphorus (Kuo, 1996 & Mcnelson et al, 1996), assignment of alternable cation (Helmke & Sparks, 1996) and the total chemical analyses were conducted based on the HF phusion (Yılmaz, 1990). The obtained analysis results were computed into the SPSS program (IBM SPSS Advanced Statistics version 19.0.0) and analysis of variance was conducted. After the analysis of variance of both the soil of the area and the soil in the mirror of the lake the difference of significant groups were analyzed with the Duncan multiple range test.

RESULTS and DISCUSSION

The results of the chemical analysis of the three different soil areas are presented in Table 1. The table shows that the soil of the Amik Lake has an average saturation value of 72.3%, a pH value of 8.24 and a total value of salinity of 0.56%. The soil of the Gavur Lake was found to have a saturation value of 101.6%, a pH value of 7.78 and a total value of salinity of 0.12%. The Gavur Lake has a higher water saturation percentage than the other two soil areas which is caused by the high level of organic matter of the soil of the lake area. The higher value of soil reaction of Lake Amik compared to the other two soil areas is explained by the fact that the deterioration value of the Amik plain is high and that it lost its wetland properties long before the Gavur Lake and the Golbasi Lakes. The decrease of organic matter which lowers pH that increased due to the dissolution of minerals in the soil plays an important role in the increase of the pH level. It was found that the soil of the Amik Lake holds 27.52% of total lime content and 0.28% of active lime, the soil of the Gavur Lake holds 19.71% of the total lime content and 0.23% of the active lime and the soil of the Golbasi Lakes holds 19.81% of the total lime content and 0.22% of the active lime. The fact that the Amik plain is surrounded by large mountains, which are generally made out of lime rocks, influenced the high level of lime content. Moreover, the finding of the high level of active lime contents in the soil of the Amik plain promotes the idea that the lime in this plain was transferred through water. In consequence of the low organic matter (1.23%) in the soil of the Amik Lake, the draining as the first dried area among the wetlands and mineralization the organic matter contents of the soils dropped a significant level. It was stated that the high level (11.42%) of organic matter in the soil of the Gavur Lake was an indication that the drying and drainage system in the lake area were not working in the expected effectiveness. The average of the useful phosphorus was found to be 6.95 mg kg^{-1}, 9.39 mg kg^{-1} and 10.69 mg kg^{-1} for the soil of the Amik, Gavur and Golbasi Lake, respectively.

Table 1. *Chemical properties of the soil of the research area*

	Satur.	pH	Total salt	Total $CaCO_3$	Active $CaCO_3$	Organic matter	Available P	Exchangeable Cations Ca	K	Mg	Na	SAR
	%		%	%	%	%	mg kg^{-1}	cmolc kg^{-1}	cmolc kg^{-1}	cmolc kg^{-1}	cmolc kg^{-1}	
						Amik Lake						
Min.	33.9	7.91	0.02	7.52	0.10	0.31	1.13	14.70	0.10	9.38	0.08	0.02
Max.	126.6	8.45	2.27	62.07	0.70	3.31	28.52	31.11	3.59	18.49	10.23	2.95
Avrg.	72.3	8.24	0.56	27.52	0.28	1.23	6.95	24.41	0.88	14.45	2.65	0.64
						Gavur Lake						
Min.	49.2	7.46	0.05	1.13	0.01	0.77	0.63	5.36	0.20	2.99	4.92	1.03
Max.	193.8	8.22	1.09	49.40	0.54	50.96	28.67	37.34	1.52	17.95	8.36	3.77
Avrg.	101.6	7.81	0.36	19.71	0.23	11.42	9.39	23.63	0.45	8.57	6.57	1.80
						Golbasi Lakes						
Min.	38.7	6.51	0.04	0.79	0.05	0.42	0.61	18.87	0.16	0.98	0.05	0.01
Max.	289.0	8.09	0.96	61.26	0.42	35.67	42.25	38.26	1.40	18.02	6.24	1.40
Avrg.	76.4	7.78	0.12	19.81	0.22	5.44	10.69	28.83	0.61	9.44	1.90	0.42

Table 2. *Total chemical analysis results of the study area soil*

	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	MnO	K_2O	Na_2O	SO_3	P_2O_5	Cl
	%	%	%	%	%	%	%	%	%	%	%	%
						Amik Lake						
Min.	50.38	3.35	3.54	0.33	11.23	0.92	0.05	0.96	0.69	0.15	0.01	0.01
Max.	72.40	9.50	6.94	0.89	28.29	3.82	0.17	2.62	3.10	3.92	0.03	0.02
Avrg.	62.49	6.01	5.30	0.52	18.01	2.19	0.11	1.86	2.20	1.13	0.02	0.02
						Gavur Lake						
Min.	47.59	4.67	1.35	0.44	9.78	0.42	0.05	0.87	1.77	0.19	0.001	0.01
Max.	74.76	9.80	4.61	0.86	28.84	3.19	0.17	2.59	3.22	3.19	0.12	0.02
Avrg.	66.22	6.79	2.81	0.62	16.08	1.86	0.09	1.43	2.60	1.48	0.04	0.02
						Golbasi Lakes						
Min.	52.60	3.38	2.03	0.34	9.65	0.35	0.05	0.96	1.25	0.00	0.00	0.01
Max.	75.83	9.87	7.77	0.66	28.91	3.19	0.20	4.22	3.30	3.63	0.19	0.02
Avrg.	66.46	6.54	4.57	0.48	14.26	1.38	0.11	2.22	2.52	1.34	0.06	0.01

The changeable Ca of the areas of study was revealed to be between 24-28 $cmol_c$ kg^{-1} and it was found to be the highest among changeable cations. The finding of a high level of calcium was caused by the widespread presence of lime rocks rich in calcium in the sedimentary rocks. Ranked as number two, Mg was found to be between 8-14 $cmol_c$ kg^{-1} and being among the ultra basic rocks serpentine, which is rich in both lime stone and Mg, takes up large areas. The changeable magnesium contents of the soil of the Amik Lake is higher than the magnesium contents of the Gavur and Golbasi Lakes because of the widespread existence of serpentine based rocks in these areas. There is a strong possibility that the reason why the changeable potassium contents of the soil of the Amik Lake are higher than those of the soils of the Gavur and Golbasi Lake is the fertilizers with potassium which are used due to a larger agricultural production in this area. As a matter of fact, it was observed during the fieldworks that agricultural production was more intensive in the Amik plain than the other areas and that a high level of fertilizers, some of which included potassium, was used. The highest sodium adsorption rate (SAR) of the three different areas of study was found in the soil of the Gavur Lake (SAR 1.80), the second highest in the soil of the Amik Lake (SAR 0.64) and the lowest in the soil of the Golbasi Lake (SAR 0.42). Because the Golbasi Lakes have lower SAR values compared to the Gavur and Amik plains, it was deduced that soil deterioration developed less, the drainage conditions are better and the main material of the area can be influential factors.

The analysis of the total element in the soil of the lake area was presented in Table 2. As a result of the analysis the total value of SiO_2 (62.49-66.46 %) was found to be of higher rate than the other elements. The second most found element was CaO (14.26-18.01 %) and the third most found was identified as the total Al_2O_3. In more detail, the total element analysis showed that the CaO was as high as 14% in the soil of the Golbasi Lake, 16% in the soil of the Gavur Lake and 18% in the soil of the Amik Lake. It was considered that the calcium level was connected with the lime rock commonly found in area and it was evaluated as product of the runoff water coming from these areas. The decline in soil reaction due to the rise in altitude and the decline in the level of total calcium oxide and magnesium oxide were evaluated as being coherent. The evidence of this phenomenon was that the value of total MgO level was the lowest in the soil of the Golbasi Lake which is also the lake with the highest altitude. The Amik Lake wetland which was the first dried area was found to have the highest total Fe_2O_3 level. The lower level of silicon and aluminium in the soil of the Amik plain compared to the other areas of study and the proportionately high level of iron oxide was interpreted as the impact of the presence of volcanic basaltic rocks. The fact that decipherable elements, such as calcium, magnesium and sodium, are cumulative in the soil profile can be asserted as an indication that the drainage system is not very prospering. The commonly found lime rocks rich in calcium and the runoff water that reaches the area through passing serpentine rocks rich in magnesium are significant factors influencing the increase in these areas. It is stated that substantial rates of sodium which cause issues in terms of alkaline soil was found and that it is necessary to monitor these areas in terms of alkaline.

The statistical analyses of the soils the Amik, Gavur and Golbasi Lake found a significant negative relationship (0.01 %) between the saturation and pH value of the soils. It is interpreted that a high saturation level indicates a high number of small particles in inorganic soils. Movements in the profile of basic elements are more limited in heavy than in light textured soil. It was observed that the movements of basic cations in heavy textured soil in wetland are bigger (Abacı Bayan, 2016). A significant positive relation was found between the saturation value of the soils and the changeable Ca and Na parameters (5 %, 5 %). Furthermore, a significant positive relation was discovered between the pH values of all soil samples and the total $CaCO_3$ and active $CaCO_3$ values (1 %, 1 %). Due to the climate zone, geological structure and geographical position of Turkey, soils hold a high level of lime and pH and low content of organic matter. A significant positive relation was reached between the soil's pH and the total lime ($p<0.01$) and a strong and positive correlation was found between the content of $CaCO_3$ and pH (Ersahin et al, 2013). The findings of the correlation analysis of the soils of study showed a significant negative relation between the pH level and the value of organic matter and phosphorus. Moreover, they also revealed a positive relation between the changeable Mg and the total MgO values (0.1 %, 5 %, 5 %).

A significant positive relation was found between the total lime and active lime content, as well as between the total lime content and changeable calcium (0.1 %). However, a negative relation was revealed between the total lime and organic matter content (1 %, 1 %).

Recent studies reported that the movement of granular, large lime in the soil is lower than the clay-sized lime which is also known as active lime (Abacı Bayan, 2016). This clay-sized lime's fraction increases in parallel with the increase of the content of lime. Conducted on the soil of the Harran plain, Şanlıurfa province, based on the horizon principles, the results of the mineralogical and chemical analysis revealed that the active lime value, which is an indicator of fine lime, increases the more the value of the total lime increases. In addition, a positive correlation was found between the active and the total lime (0.1 %) (Yılmaz, 1997). Similar results were reported in the studies by Reyes et al (2006) and Altun Gül & Karaca (2011). A significant positive relation was found between the active lime content in the soil and the changeable calcium content (1 %). It was stated by Yaloon (1957) that the concentration of calcium and ion in the soil is increased by the large rate of $CaCO_3$ content in the soil. A significant negative relationship was identified between the useful phosphorous contents and changeable calcium. Moreover, a significant negative relationship was found between the useful phosphorous contents and changeable magnesium (1 %, 0.1 %). This negative relationship revealed that a high level of Ca and Mg had an impact on the phosphorous level which can be obtained in circumstances where the pH of the soil is alkaline. The results of the statistical analyses indicated a significant negative relationship between the changeable calcium content and rate of sodium adsorption (0.1 %). Calcium, which ensures flocculation, and sodium, which causes dispersion, possess opposite movement mechanisms. Similar findings were reported by the studies of Olusegun and Samuel (2014) and Mahmood et al (2013).

The correlation analysis resulted with a negative relation between the changeable magnesium content and SAR. Moreover, a negative relation was found between the changeable magnesium content and P_2O_5 (5 %, 5 %). In a study on the Malaysian forest soils, a high value of changeable cations was reported despite the low number of the total phosphorous content (Amlin et al, 2013). A significant negative relationship was reached between the changeable sodium content and Fe_2O_3 content, and a positive relationship between the changeable sodium content and SAR value. Consistent results were found in the soil sediments of wetland in the south-west of Nigeria (Olusegun and Samuel, 2014). The statistical analyses found a significant negative relationship between the contents of the rate of sodium adsorption of the soils and the P_2O_5 content (5 %). In the study on saline soil, it was reported that the more the total phosphorous content increases, the lower the SAR value drops (Mahmood et al, 2013).

After the one-way analysis of variance on the chemical distribution of the soils of study, the significant groups were compared with the use of the Duncan Multiple Rage test and the results are presented in Table 3. The reason why the saturation percentage of the Gavur Lake is different and higher than the other two lake soils is the fact that the soil of the Gavur Lake holds a large rate of organic matter. The finding that the soil reaction of soil of the Amik Lake is different and higher from the other two lake soils is a result of not only the high total and active lime contents in the soils of the areas of study, but also the very low organic matter, useful phosphorous and elevation. It was interpreted that the lower value of salinity of the soil of Golbasi Lakes compared to the other two lake soils is an indication of the low level of degradation and minor misuse leading to salification on these soils.

The fact that the large mountains surrounding the Amik plain are generally made out of lime rocks in terms of active lime properties, that these soils hold a high amount of lime content and that the active lime properties are also high supports the idea that the lime of the plain was carried through water. The amount of organic matter of the soil of Amik Lake rapidly decreased depending on the oxidation conditions because of its low organic matter content and being dried before the other soil areas of study. Among the soils of study, the least degraded ground soil is the soil of Golbasi. Because the lake is being protected, the soil samples were collected from the coastal region of the lake. In spite of the fact that the soil's organic matter level was found to be lower than the soil of the Gavur Lake, it is detected that the organic matter level of the organic profiles are high once the mineral profiles are overlooked. A strong possibility exists that the reason why the soils of the Amik Lake possesses a higher and statistically different level of changeable potassium contents from the Gavur and Golbasi Lake soils is the fact that more intensive agricultural production were conducted in this area compared to the other two areas which lead to the use of potassium fertilizers. Indeed, it was observed during the fieldworks that the Amik plain is more intensively used for agriculture than the other areas, that an extensive amount of agricultural fertilizers are used and that potassium fertilizers are among these fertilizers. The finding of the lowest silicon and aluminum level in the soil of the Amik plan and the highest level of iron oxide is considered to be caused by the features of the main material in the soil region. Furthermore, the presence of large basaltic areas rich in iron close by Hassa, which sustains the plain, is considered to be influential in the high level of iron oxide.

It was interpreted that the high amount of total $CaCO_3$ content in the soil of the Amik plain, and consequently, a higher level of CaO in these soils is effective in the scarcity of SiO_2. It was found that the level of total potassium in the soils of the Golbasi Lakes are higher compared to the other lake soils, and the total potassium level of the soil of Gavur Lake was revealed to be the lowest. It was observed in the fieldworks that the use of potassium fertilizers in the Amik plain was considerably higher than the other areas due to intensive agricultural activities. As a result of this implementation, the level of changeable potassium was found to be higher than the other areas.

Table 3. *Duncan Test results of soil chemical properties*

Area	Satur.	pH	Total salt	Total $CaCO_3$	Active $CaCO_3$	Organic matter
	%		%	%	%	%
Amik Lake	$72.3^b \pm 8.4$	$8.2^a \pm 0.5$	$0.6^a \pm 0.06$	$27.5^a \pm 2.48$	$0.3^a \pm 0.02$	$1.2^c \pm 1.33$
Gavur Lake	$101.8^a \pm 7.4$	$7.8^b \pm 0.5$	$0.4^a \pm 0.08$	$19.7^b \pm 2.17$	$0.2^{ab} \pm 0.02$	$11.4^a \pm 1.16$
Golbasi Lake	$76.4^b \pm 5.7$	$7.8^b \pm 0.4$	$0.1^b \pm 0.09$	$19.8^b \pm 1.69$	$0.2^b \pm 0.02$	$5.4^b \pm 0.91$
Significant level	$p<0.012$	$p<0.00$	$p<0.00$	$p<0.025$	$p<0.00$	$p<0.00$

Mean values indicated by different symbols in the same column are statistically significant at $p \leq 0.05$ level according to Duncan test.

Table 4. *Duncan Test results of soil chemical properties (continue)*

Area	Available P	Exchangeable Cations Ca	K	Mg	Na	SAR
	mg kg^{-1}	cmol$_c$ kg^{-1}	cmol$_c$ kg^{-1}	cmol$_c$ kg^{-1}	cmol$_c$ kg^{-1}	
Amik Lake	6.95±1.54	24.41^b±1.04	0.88^a±0.09	14.45^a±0.72	2.65^b±0.40	0.64^b±0.11
Gavur Lake	9.39±1.35	23.63^b±0.91	0.45^b±0.08	8.57^b±0.63	6.57^a±0.35	1.80^a±0.10
Golbasi Lake	10.69±1.05	28.83^a±0.70	0.60^b±0.06	9.44^b±0.49	1.90^b±0.27	0.42^b±0.08
Significant level	p<0.06	p<0.00	p<0.001	p<0.00	p<0.00	p<0.00

Mean values indicated by different symbols in the same column are statistically significant at p≤0.05 level according to Duncan test.

CONCLUSION

In conclusion, having undergone various agricultural activities, the soil of the Amik Lake has lost its properties as a wetland due to its high level of soil deterioration based on its earlier drying compared to the other lake soils. Despite the areal rise in the agricultural land through drying, it was concluded that nowadays the soil productivity in terms of plant production of the Amik plain is low and that issues will be encountered in the future, considering the existing negative properties of the soil. Being dried in the second rank, the Gavur Lake became a wetland. It was realized that agricultural production did not develop to the expected level in the area which is under water for most of the year due to the lack of drainage channels in the soil. Additionally, it was observed that these wetland areas were lacking in providing economic and natural contributions because it lost the property of being a wetland. Having the least soil deterioration and being protected by the ministry of forestry and water affairs, the Golbasi Lakes were detected to maintain the wetland property of their soils at better level compared to the other lake soils (Abacı Bayan, 2016).

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