DISTRIBUTION AND FACTOR ANALYSIS OF SOIL ORGANIC CARBON IN SOILS FOR GRAPEVINES FROM SELECTED MICROLOCATIONS IN THE OVCHE POLE VINE DISTRICT

[1]Aleksandar Piperevski, [1]Biljana Balabanova

[1]Faculty of Agriculture, Goce Delcev University, Krste Misirkov 10-A, 2000 Stip, Republic N. Macedonia

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ABSTRACT

Soil organic carbon (SOC) represents a fundamental indicator of soil quality, directly influencing nutrient cycling, structural stability, and long-term sustainability in viticultural systems. This study evaluates the distribution of SOC and its controlling factors in vineyard soils from six microlocations within the Ovče Pole wine-growing district (North Macedonia). A total of 18 composite soil samples were collected from the surface layer (0-30 cm) and analyzed for SOC using the Walkley-Black titrimetric method, a validated and widely applied procedure for routine soil carbon determination. The obtained SOC values ranged from 0.76% to 1.32%, with a mean value of 1.13%, indicating predominantly low to moderate organic carbon status.

INTRODUCTION

Soil properties play a crucial role in determining soil quality and productivity in soils for grapevines. Among them, soil organic carbon (SOC) is of particular importance due to its influence on nutrient availability, soil structure, and biological activity. SOC is closely linked to organic matter and affected by various soil parameters, such as pH, nutrient content, and other physicochemical characteristics. These interactions influence the distribution and stability of organic carbon in soil. Understanding these relationships is essential for evaluating soil conditions and supporting sustainable management in viticultural regions.

MATERIALS AND METHODS

A total of 18 composite soil samples were collected from the surface layer (0-30 cm). The coordinates and sampling locations are presented in Table 1, while the geographical position of Ovče Pole Vine District is shown in Figure 1.

Table 1. Labels, locations and coordinates of the unified soil samples

Sample	Location	Coordinates
L1S1	Tri Cesmi	41°45'58.76"N 22°07'58.07"E
L1S2	Tri Cesmi	41°46'22.75"N 22°07'30.16"E
L1S3	Tri Cesmi	41°46'11.48 "N 22°07'48.64"E
L2S1	Krivi Dol	41°47'33.00"N 22°05'39.79"E
L2S2	Krivi Dol	41°47'33.00"N 22°05'45.95"E
L2S3	Krivi Dol	41°47'45.39"N 22°05'31.65"E
L3S1	Balvan	41°48'55.42"N 22°12'08.39"E
L3S2	Balvan	41°48'53.80"N 22°12'30.02"E
L3S3	Balvan	41°48'54.62"N 22°12'20.40"E
L4S1	Radanje	41°48'06.15"N 22°16'20.75"E
L4S2	Radanje	41°48'54.62"N 22°12'20.40"E
L4S3	Radanje	41°47'05.07"N 22°16'00.52"E
L5S1	Argulica	41°48'32.69"N 22°16'53.46"E
L5S2	Argulica	41°48'43.79"N 22°16'29.79"E
L5S3	Argulica	41°48'42.66"N 22°16'34.63"E
L6S1	Dolno Trogerci	41°49'46.01"N 22°09'37.92"E
L6S2	Dolno Trogerci	41°49'44.66"N 22°09'43.41"E
L6S3	Dolno Trogerci	41°49'47.06"N 22°09'44.51"E

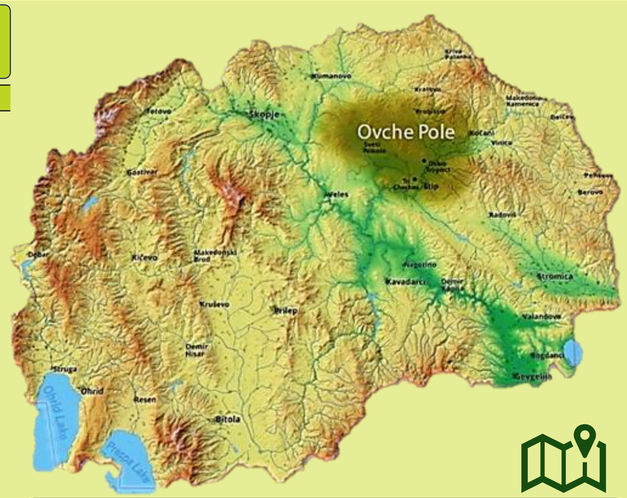

Figure 1. Geographical position of Ovče Pole vine District

SOC analyses were performed using the Walkley–Black method, a validated and widely used procedure for routine soil organic carbon determination, while the basic chemical analyses were carried out using certified standard methods.

RESULTS AND DISCUSSION

Table 2. Selected chemical parameters and SOC content of soils for grapevines from the Ovče Pole region

Sample	pH H_2O	pH KCl	EC (µS/cm)	N (g/kg)	P_2O_5(mg/100g)	K_2O(mg/100g)	OM (%)	OC (%)	$CaCO_3$ (%)
L1S1	7.68	7.52	394	1.17	19.2	24.80	2.13	1.16	1.22
L1S2	8.02	7.63	727	0.36	17.3	30.13	2.25	1.25	7.13
L1S3	7.48	7.11	323	1.11	25.8	50.21	1.79	1.10	0.75
L2S1	7.75	7.52	335	1.15	28.3	30.30	1.96	1.15	0.77
L2S2	8.16	7.92	862	1.16	13.5	43.25	1.83	1.12	0.72
L2S3	7.68	7.52	327	1.17	10.8	44.50	2.11	1.26	11.4
L3S1	7.12	6.95	491	1.14	10.2	41.11	1.52	0.91	10.5
L3S2	7.57	7.66	560	1.12	13.4	45.24	1.78	1.11	11.1
L3S3	7.29	7.67	560	1.14	20.1	49.60	2.03	1.21	8.56
L4S1	7.72	7.54	462	1.11	23.5	40.22	2.46	1.15	12.6
L4S2	7.12	7.02	461	1.13	25.1	30.12	2.22	1.26	22.1
L4S3	6.72	6.54	326	1.12	22.2	30.11	1.87	1.10	11.4
L5S1	6.83	6.12	270	1.20	21.0	100.2	1.39	1.15	1.72
L5S2	7.80	7.50	220	0.95	25.1	120.3	2.50	1.32	2.21
L5S3	7.66	7.22	320	0.89	17.9	141.2	1.17	0.76	1.63
L6S1	7.15	7.01	420	1.16	17.6	90.80	1.17	0.87	1.11
L6S2	6.41	7.10	430	1.17	18.9	92.55	1.22	0.82	0.85
L6S3	6.62	6.21	270	1.17	19.9	101.2	1.63	1.11	0.92

Table 3. Factor analysis (FA) of soil properties

Parameter	F1	F2
pH-H_2O	-0.21	0.62
pH-KCl	-0.35	0.68
EC	0.25	0.71
N	0.72	-0.10
P_2O_5	0.30	0.22
K_2O	0.28	0.18
OM	0.94	-0.05
OC	0.97	-0.03
$CaCO_3$	-0.22	0.76
Eigenvalue	4.11	2.18
Variability (%)	45.7	24.2

The studied soils are neutral to slightly alkaline (pH 6.41–8.16) with low electrical conductivity, indicating no salinity limitations. $CaCO_3$ content shows notable variability (0.72–22.1%), reflecting differences in soil formation conditions. SOC values (0.76–1.32%) indicate low to moderate levels typical for soils for grapevines. Strong positive relationships between SOC, OM, and N confirm their key role in soil fertility. Factor analysis revealed two dominant factors: a fertility-related factor (SOC, OM, N; 45.7%) and an alkalinity-related factor (pH, $CaCO_3$; 24.2%).

CONCLUSION

SOC distribution is associated with organic matter and key soil chemical properties, reflecting their combined influence on soil conditions. Fertility-related parameters dominate SOC variability, while pH and $CaCO_3$ influence its distribution under alkaline conditions. These findings emphasize the importance of proper soil management for maintaining soil quality in soils for grapevines.

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