Variation of the Chemical Element Content in the Dealu Bujorului Vineyard Soil

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Abstract

The purpose of this study is to know better the concentration of chemical elements in the soil from Dealu Bujorului vineyard. The determination of the ten elements from the soil samples was performed using ICP-MS. The results showed diverse patterns of cadmium, lead, uranium, mercury, arsenic, strontium, cobalt, copper, nickel and chromium, all the elemental content studied were under the maximum limit admitted, except for copper (average 356.03 mg/kg while M.L.A. = 20 mg/kg).

Keywords: Dealu Bujorului vineyard, elemental concentration, vineyard soil

Introduction

In modern ecology, soil pollution is any action which results in disruption of the normal operation of the soil (Bora *et al.*, 2015). Appearance of the elements in vineyard soil could be attributted to the application of organic and mineral fertilizers, inorganic pesticides and other substance used in growing practices. Phosphatic fertilizers has higher concentration of Cd compared with other fertilizers (Ramachandran and D'Souza, 1998). Also, pesticides may increase the contents of Cu, As and Zn. Environmental pollution was not directly associated with viticulture practice. This source is mainly related to suspend particular matter or natural pollution, leading to an increase of lithophile elements (Al, Mn, Sr, Ti) or of anthropogenic origin, leading to higher flux of volatile elements (Cd, Ni, Pb, V and Zn). Various soil properties, e.g. organic matter content, can have a strong influence on progressive transition metal accumulation (Alloway, 1990). It is well known that metals in low contents such as Cu, Zn, Mo and Mn are essential for plant growth (Marschner, 1995), but they have also adverse effects on growth, therefore is necessary to improve our knowledge of the influence of contaminated soil on the grapevine growth (Frías *et al.*, 2001; Jakubowski *et al.*, 1999; Kment *et al.*, 2005).

Materials and methods

Soil samples were harvested from Dealu Bujorului vineyard (45°52′10″ N, 27°55′8″E), the scattered spreading territory of this vineyard corresponds almost entirely to the geographical subunit known as Colinele Covurluiului, in these area is also located the Dealu Bujorului vineyard. The vineyard is crossed by the parallel 46° latitude north, intersected by the 28° longitude meridian.

Dealu Bujorului vineyard belongs to Galați country. The specificity of the transition area is highlighted by the predominance of deposits of clays and sands. Versants were made from clay deposits and sandy sands.

Soil samples (3 samples / depth) were collected from 10 in 10 cm to a depth of 120 cm. Ecopedological conditions of Dealu Bujorului vineyard are presented in Blaga *et al*. (2005) and Toti *et al*. (2017). Soil samples were collected using stainless steel shovels and were stored in individual black plastic bags (darkness). All samples were taken in triplicates from the defined experimental plot.

Soil samples have been brought first to sand-size material (< 2 mm) using a jaw crusher then mechanically split to obtain a representative samples and eventually pulverized to powder-size, grain-size smaller than 100 μ (< 400 mesh), using a ball mill. Agate ball mill is used in place of any other pulverization metal device to avoid possible trace element contamination.

For the determination of elemental concentration from soils, there were used 0.5 mL soil and adjust with 8 mL (7 mL HNO_3 65% + 1 mL H_2O_2), after 15-30 minutes the mineralization was performed using a microwave system Milestone START D Microwave Digestion System set in three steps: step I (time 10 min., temperature 220ºC), step II (time 15 min., temperature 220ºC) and step III (time 60 min., ventilation - temperature 35ºC). The analysis was made using multielement analysis and ICP-MS technique, after an appropriate dilution, using external standard calibration method. The calibration was performed using XXICertiPUR multielement standard and from individual standard solution of Cr and Hg. The determination methods for elements concentration from soils was optimized in a previous work (Bora *et al.*, 2018).

The aim of this study is to obtain the overview on elemental concentration from Dealu Bujorului vineyard soil.

Results and discussions

Regarding the concentration of elemental content from Dealu Bujorului vineyard soil, the highest concentrations were recorded on surface of the soil profile [Cu 527.35 ± 3.29 mg/kg (0-10 cm); 525.27 ± 6.05 (10-20 cm) mg/kg) and Cr 14.13 ± 0.76 mg/kg (30-40); 13.42 ± 0.25 mg/kg (20-30 cm)] but these concentrations decrease with increasing depth of the soil profile [Cu 313.66 ± 3.78 mg/kg (100-110 cm); 222.55 ± 11.35 (110-120 cm) mg/kg) and Cr 8.91 ± 0.40 mg/kg (110-120 cm)]. Exception to this rule is As: increasing the depth of the soil profile also increases the concentration of it in vineyard soil [Pb 0.47 ± 0.05 mg/kg (0-10 cm); 0.54 ± 0.04 (10-20 cm) mg/kg)]; if the depth of the soil profile is from 100-120 cm than the concentration decreases [As 1.33 ± 0.02 mg/kg (100-110 cm); 1.22 ± 0.15 mg/kg (110-120 cm)]. The data showed high concentration of Cu in Dealu Bujorului vineyard soil. This metal concentration in the topsoil of Dealu Bujorului vineyard plots significantly surpass the maximum values reported in literature 1500 mg/kg (Flores-Veles *et al.*, 1996). The copper enrichement in different vineyard soil types reflects the period of copper-based pesticide application (Flores-Veles *et al.*, 1996).

The results obtained are comparable to those obtained by Albulescu *et al*. (2009) 1.77 [Cd (mg/kg)], 21.63 [Pb (mg/kg)], 24.55 [Ni (mg/kg)], 13.32 [Cr (mg/kg)]; Alagić *et al*. (2014) 3.14 ± 0.03 [Cd (mg/kg)], 42.80 [Pb (mg/kg)], 10.70 ± 0.01 [As (mg/kg)], 293.00 [Cu (mg/kg)] but also Bravo *et al*. (2017) 16.18 ± 5.20 [Pb (mg/kg)], 241.88 ± 493.40 [Sr (mg/kg)], 10.87 ± 5.10 [Cu (mg/kg)]. Regaring the results obtained by Huzum *et al.*, 2012 background area (Huși area) there were higher [22.90 Pb (mg/kg), 13.20 As (mg/kg), 14.00 Co (mg/kg), 45.00 Ni (mg/kg), 140.00 Cr (mg/kg)] compared with the results obtained in thgis study [7.00 Pb (mg/Kg), 1.29 As (mg/Kg), 3.76 Co (mg/kg), 5.68 Ni (mg/kg), 11.04 Cr (mg/kg)] exception does Cd 0.19 Cd (mg/kg) (Huzum *et al.*, 2012) - 0.37 Cd mg/kg and also Cu 79.30 Cu (mg/kg) (Huzum *et al.*, 2012) - 356.03 Cu (mg/kg).

Conclusions

The results of this study showed diverse patterns of Cd (average 0.37 mg/kg while M.L.A. (Maximum Admissible Limit) = 1 mg/kg), Pb (average 7.00 mg/kg while M.L.A. = 20.00 mg/kg), U (average 0.36 mg/kg), Hg (average 0.1 mg/kg while M.L.A. = 20.00 mg/kg), As (average 1.29 mg/kg while M.L.A. = 5.00 mg/kg), Sr (average 36.35 mg/kg), Co (average 3.73 mg/kg while M.L.A. = 15.00 mg/kg), Ni (average 5.68 mg/kg while M.L.A. = 20.00 mg/kg) and Cr (average 11.04 mg/

Table 1. Variation of the metal content of vineyard soil from Dealu Bujorului (mg/kg) (Mean ± standard deviation) (n = 3)

Area	Type of soil	Depth (cm)	Total metal concentration									
			Cd	Pb	U	Hg	As	Sr	Co	Cu	Ni	Cr
			M.A.L.**	M.A.L.	M.A.L.	M.A.L.	M.A.L.	M.A.L.	M.A.L.	M.A.L.	M.A.L.	M.A.L.
*Normal Values			1 mg/kg	20 mg/kg	-	0.1 mg/kg	5 mg/kg	-	15 mg/kg	20 mg/kg	20 mg/kg	30 mg/kg
Alert threshold	Susceptible		3 mg/kg	50 mg/kg	-	1 mg/kg	15 mg/kg	-	30 mg/kg	100 mg/kg	75 mg/kg	100 mg/kg
Less Susceptible		5 mg/kg	250 mg/kg	-	4 mg/kg	25 mg/kg	-	100 mg/kg	250 mg/kg	200 mg/kg	300 mg/kg	
Intervention threshold	Susceptible		5 mg/kg	100 mg/kg	-	2 mg/kg	25 mg/kg	-	50 mg/kg	200 mg/kg	150 mg/kg	300 mg/kg
Less Susceptible		10 mg/kg	1.000 mg/kg	-	10 mg/kg	50 mg/kg	-	250 mg/kg	500 mg/kg	500 mg/kg	600 mg/kg	
Dealu Bujorului Vineyard	Chernozem	0-10	0.40 ± 0.12 cd	7.52 ± 0.40 cd	0.48 ± 0.11 ab	0.051 ± 0.009 b	0.47 ± 0.05 f	42.73 ± 2.66 a	2.33 ± 0.97 d	527.35 ± 3.29 a	9.50 ± 1.08 a	12.34 ± 1.21 bc
		10-20	0.21 ± 0.04 fg	9.79 ± 0.13 b	0.52 ± 0.06 a	0.079 ± 0.014 a	0.54 ± 0.04 f	40.55 ± 2.15 ab	3.27 ± 0.03 cd	525.27 ± 6.05 a	8.52 ± 1.18 b	12.35 ± 1.03 bc
		20-30	0.34 ± 0.10 cde	12.92 ± 1.61 a	0.35 ± 0.10 cde	0.073 ± 0.015 ab	0.90 ± 0.03 e	39.58 ± 2.06 ab	3.49 ± 0.47 c	522.77 ± 9.90 a	6.34 ± 0.70 c	13.42 ± 0.25 ab
		30-40	0.45 ± 0.09 dc	9.89 ± 0.59 b	0.38 ± 0.07 bcde	0.062 ± 0.020 ab	1.61 ± 0.15 b	40.71 ± 0.52 ab	4.78 ± 0.55 ab	511.79 ± 3.29 b	5.98 ± 1.17 cd	14.13 ± 0.76 a
		40-50	0.32 ± 0.02 def	9.05 ± 1.43 bc	0.45 ± 0.04 abc	0.049 ± 0.019 b	1.39 ± 0.12 bc	39.51 ± 1.79 ab	3.47 ± 0.59 c	330.12 ± 3.72 e	4.79 ± 0.59 cde	12.81 ± 0.97 ab
		50-60	0.18 ± 0.07 g	7.58 ± 0.68 cd	0.42 ± 0.01 abcd	0.085 ± 0.011 a	1.61 ± 0.07 b	42.60 ± 0.53 a	4.62 ± 0.34 b	364.79 ± 8.33 d	3.84 ± 0.55 e	10.19 ± 0.72 de
		60-70	0.25 ± 0.07 efg	2.91 ± 0.66 f	0.40 ± 0.02 abcde	0.084 ± 0.012 a	1.08 ± 0.13 de	41.32 ± 0.77 ab	5.73 ± 0.84 a	402.06 ± 0.62 c	5.44 ± 0.13 bcd	10.15 ± 0.67 de
		70-80	0.53 ± 0.02 b	3.76 ± 0.98 f	0.37 ± 0.03 bcde	0.073 ± 0.013 ab	2.55 ± 0.30 a	38.90 ± 2.26 b	5.09 ± 0.60 ab	326.31 ± 5.46 e	4.34 ± 0.36 de	10.86 ± 1.10 cd
		80-90	0.43 ± 0.02 bcd	4.09 ± 0.81 f	0.29 ± 0.02 e	0.083 ± 0.009 a	2.29 ± 0.07 a	38.89 ± 0.66 b	3.02 ± 0.74 cd	123.93 ± 4.62 h	4.30 ± 0.51 de	10.69 ± 1.30 d
		90-100	0.64 ± 0.01 a	3.57 ± 0.02 f	0.34 ± 0.09 cde	0.080 ± 0.002 a	1.53 ± 0.39 b	28.48 ± 3.57 c	3.36 ± 0.36 cd	128.10 ± 2.58 h	4.47 ± 0.59 de	7.49 ± 0.06 f
		100-110	0.35 ± 0.04 cde	5.83 ± 1.15 e	0.31 ± 0.08 de	0.072 ± 0.023 ab	1.33 ± 0.02 bcd	23.82 ± 1.55 d	2.34 ± 0.15 d	313.66 ± 3.78 f	6.50 ± 0.42 c	9.08 ± 0.90 e
		110-120	0.33 ± 0.06 cde	7.12 ± 1.27 de	0.32 ± 0.06 de	0.087 ± 0.004 a	1.22 ± 0.15 cd	22.70 ± 1.25 d	3.28 ± 0.08 cd	222.55 ± 11.35 g	5.22 ± 0.12 bcd	8.91 ± 0.40 e
Average			0.37 ± 0.05	7.00 ± 0.81	0.36 ± 0.06	0.075 ± 0.013	1.29 ± 0.10	36.65 ± 1.65	3.73 ± 0.48	356.03 ± 4.36	5.68 ± 0.53	11.04 ± 0.78
Minumum Values			0.18 ± 0.07	2.91 ± 0.66	0.29 ± 0.02	0.051 ± 0.009	0.47 ± 0.05	22.70 ± 1.25	2.33 ± 0.97	123.93 ± 4.62	3.84 ± 0.55	7.49 ± 0.06
Maximum Values			0.64 ± 0.01	12.92 ± 1.61	0.52 ± 0.06	0.087 ± 0.004	2.29 ± 0.07	42.73 ± 2.66	5.73 ± 0.84	527.35 ± 3.29	9.50 ± 1.08	14.13 ± 0.76
F.			13.471	32.412	3.603	2.579	41.035	44.554	11.380	1775.689	18.218	16.280
Sig.			***	***	**	*	***	***	***	***	***	***
Depth		F.	15.265	31.258	3.107	1.254	45.198	34.564	14.491	1547.165	14.561	17.125
Sig.		***	***	*	*in*	***	***	**	***	***	***	
Huzum *et al.*, 2012 ***			0.21	12.90	-	-	11.20	-	7.20	256.00	29.9	208.00
Albulescu *et al.*, 2009			1.77	21.63	-	-	-	-	-	-	24.55	13.32
Alagić *et al.*, 2014			3.14 ± 0.03	42.80	-	-	10.70 ± 0.01	-	-	293.00	16.67 ± 0.09	-
Bravo *et al.*, 2017			-	16.18 ± 5.20	-	-	-	241.88±493.40	-	10.87 ± 5.10	-	-

Average value ± standard deviation (n = 3). Romans letters represent the significance of the variety difference ($p \leq 0.05$). The difference between any two values, followed by at least one common letter, is insignificant. *Order of the Ministry of Waters, Forests and Environmental Protection No. 756/3 November 1997, approving the regulation on the assessment of environmental pollution, Bucharest, Romania; 1997. **M.A.L (Maximum Admissible Limit) = Normal Values. in = insignificant. S.A.T. = Susceptible Alert Threshold. *** reference values / background area (Huşi area).

kg while M.L.A. = 30.00 mg/kg), all the elemental studied were under the maximum limit admitted, except for Cu (average 356.03 mg/kg while M.L.A. = 20 mg/kg; S.A.T. (Susceptible Alert Threshold) = 100 mg/Kg). A possible explanation for the high concentration of Cu obtained was the application of different Cu formations against wide rage of insect pests and diseases during the time.

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