SINAI Journal of Applied Sciences (ISSN: 2314-6079) Vol. (6) Is. (2), Aug. 2017 181-192

SINAI Journal of Applied Sciences

ARU-EGYPT SJAS Trust Science | It Creates

SELENIUM STATUS IN SOME NORTH SINAI SOILS

2. INLAND AREA

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ABSTRACT

The present study was conducted during the two seasons of 2013/2014 and 2014/2015 in North Sinai Governorate to investigate the spatial variations of (se) concentrations in inland area. Two range plants (atriblex and acacia) were used as indicators plants. Selenium status, (total and available) were determined in the soils of inland area of the governorate including (El-Hassana and Nekhl). Soil samples were taken from (0-30, 30-60, 60-90 and 90-120cm) layers. Soil samples were taken from three sites at any location were Atriblex or acacia range plants were naturally grown. Leaves samples from two studied range plants were taken on April during the two studied seasons, while selenium concentrations were determined in such plant samples. The obtained results indicated that total selenium concentrations in the studied soils ranged from 0.10 ppm to 0.45 ppm in the whole inland area studied soils compared to global crustal concentrations of 0.083 ppm. The high content of the total selenium concentration under such condition may be due to the effect of dry deposition of dust. The obtained results cleared that the selenium contents in inland area are lower than that under crustal area. Hence geographical aspects, specially the distance from sea could not be complete ignored with respect to the selenium status under different studied areas conditions. With respect to extractable Se from the studied soils, obtained results revealed that the Se extractable using DTPA ranged from 0.010 ppm to 0.022 ppm, compared to those extracted with water and $CaCl_2$ which ranged from 0.010 to 0.019 ppm and 0.011 to 0.018 ppm, respectively. It is worth to mention that Se extracted with DTPA was higher than that extracted using other two extract agents. At all cases, using all studied extracting agents, extracted only a few quantities which ranged from 3.12% to 16.36% of total Se in the studied soils. Such obtained results revealed that most total Se in the studied soils found in forms not extracted with the studied extracting agents and hence, not available for plant absorption. The average selenium concentrations in the two studied range plants varied from 2.87 to 3.46 ppm in atriplex compared to 0.17 and 0.29 ppm in acacia plant. Such results clear that the potential differences between range plants used by animals with repect to selenium concentration.

Key word: Selenium, North SINAI, soils, inland area.

INTRODUCTION

Selinun in soils can originate from both local and regional sources. The first source include rocks (geogenic sources) which Se can be formed through weathering and leaching of native rocks. As well as anthropogenic sources like Se fertilizers. The sources which add selenium to the soil include wet and dry atmospheric deposition. Although geogenic sources may be the major local source of selenium in soils, a

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comparison between the average Se content in soils (ranging from 0.01 to 2.0 mg per kg, world mean is 0.4 mg per kg). While the average selenium concentration in the Earth crust is 0.05 mg per kg, the surface sources like atmospheric deposition may cause an important role in the presence of selenium in the soil.

Atmospheric fallout and parent materials may be the main factors affecting total Se content in the soils **(Wang *et al.*, 1995 and Cao *et al.*, 2007).** Surface soil receive more fallout and get more Se content than subsoil especially in the coastal areas. **Sun *et al.* (2016)** reported that the North western dry region (<400mm) exhibit high Se especially in the arid environment with annual deposition less than 200mm such effect could be due to dry or dust deposition which can reach to 200g/m^2/year at local scale (0-10 km from dust source) and 20g/m^2/year at regional scale (10-1000 km from dust source), respectively much higher than (0.4g/m^2/year) at global scale (>1000 km) from dust source **(Lawrence and Nefff, 2009; Zhang, 2003)**.

Global Se dry deposition has been estimated to be 1.7-24×10^9 g Se per year, less than wet deposition of 3.5-10×10^9g Se per year. Aerosol concentration of Se has been demonstrated to be highly enriched relative to average crustal abundance **Ghauri (2001) and (Vriens *et al.*, 2014).** In regions with low precipitation, such as the Mediterranean climate area, dry deposition is more important than wet deposition on an animal basis **(Muezzinogiu and Cizmecioglu, 2006).** Thus the relative importance of wet versus dry deposition may not only depend on the efficiency of these two mechanisms but it also varies with the local availability of precipitation **(Muezzinglu and Cizmecioglu, 2006).** The aim of the present investigate was to evaluate the selenium status under remote locations of North Sinai soils as well as some range plants grown in that soils.

MATERIALS AND METHODS

The selenium status in North Sinai in inland soils was studied in both El-Hassana and Nekhl inland location are 20 and 25 mm, respectively **(Annual Report, 2015)**. The inland area in the governorate include both of El-Hassana and Nekhl locations.

Naturally grown Atriblex and acacia range plants were used as indicator plants. Soil samples from the layers of 0-30, 30-60, 60-90 and 90-120 cm were collected from three sites in every location and analyzed for both physical and chemical properties as well as both total and extracted selenium using water, $CaCl_2$ and DTPA. Plant samples (leaves) were collected from the two studied range plants with the soil samples during two successive seasons (2013/2014 and 2014/ 2015) and selenium content in the plant material was detected. Physical and chemical properties of the soil samples were determined using standard methods. **Dan (1957) Gee and Bander (1986)**. The main physical and chemical properties of the studied soils are presented in Table 1.

Analysis of Soil Selenium

-Total selenium of the studied soils was determined using the method of **Elsokkary and Oien (1977).**

-Water soluble selenium was determined using the method of **Gissel-Nelson (1976).**

Analysis of Plant Selenium

Selenium concentration of plant samples were determined using the method of **Olson (1973).**

Statistical analysis

Correlation (pearson) analysis was used to determine relations between some soil parameters and both extractable Se in the soil and that in both studied plants **(SPSS, 2010).**

Table (1): Main physical and chemical properties of the studied soil in inland area of North Sinai Governorate.

Parameter	Rang value
Clay (%)	2.2 – 12.70
Silt (%)	8.6 – 27.3
Coarse sand (%)	40.9 – 55.0
Fine sand (%)	20.0 – 30.6
PH	7.43 – 7.96
EC, dsm^{-1}	2.01 – 6.21
Calcium carbonate (%)	12.21 – 23.7
Organic matter (%)	0.022 – 0.080
Cation exchange capacity, cmol kg^{-1}	7.33 – 12.72
Total selenium, mg kg^{-1}	0.10 – 0.45
Water soluble selenium, mg kg^{-1}	0.01 – 0.019
Ca Cl_2 soluble selenium, mg kg^{-1}	0.011 – 0.018
DTPA soluble selenium, mg kg^{-1}	0.01 – 0.022

- Calcium chloride $CaCl_2$ extractable selenium was determined using the method of **Gissel-Nelson (1973).**
- DTPA extractable selenium was determined using the method of **Lindsay and Norvell (1978).**

RESULTS AND DISCUSSION

Total selenium content in the soil obtained results in Tables (2, 3 and 4) show that the total selenium content in Atriblex growing soils of El-Hassana ranged between 0.11 and 0. 28 ppm.

The corresponding values under acacia growing soils were between 0.11 and 0.32 ppm. The variation may be to depending on site location and soil depth. The obtained results also show that the highest values (0.26 and 0.46 ppm) of total selenium were found in the surface layer (0-30cm) in the atribex growing soils in both El-Hassana and Nekhl locations while the lowest values (0.1 and 0.012 ppm) were found in the 90-120cm layer. The crrosponding values for acacia growing soil were (0,1-0.11ppm) Such findings were found true in both two studied locations (El-Hassana and Nekhl).

It's clear that the total selenium contents in the two studied locations were higher in the surface soil layers than in the Earth crust content of selenium (0.081 ppm). Such findings may indicate that the total selenium in the upper surface layers is external in nature due to dry deposition **(Sun *et al.*, 2016).**

Selenium Extracted From the Soil

Obtained results in Tables 5, 6 and 7 indicate that the concentration of selenium extracted from the soils varied from extracting agent to another. Selenium content extracted from El-Hassana soil ranged between 0.010 and 0.013 ppm using water.

On the other hand, obtained results clear that the percent extracted values ranged from 3.12% to 9.09% Such obtained values may indicate that, most of total selenium in the soil are exit in non-soluble form which are not available for plant absorption. Selenium extracted using water from Nekhl soils ranged from 0.11ppm to 0.019ppm while the percent extraction values ranged from 4.22% to 11% in both two studied range plans growing soils.

Table (2): Total selenium content, (ppm) in El-Hassana soils during the two studied seasons of 2013-2014 and 2014-2015.

Selenium concentration, (ppm)							
	First season			Second season			
Atriblex growing soils							
Soil depth, (cm)	Site1	Site2	Site3	Site1	Site2	Site3	Average
0-30	0.27	0.27	0.28	0.28	0.26	0.28	0.28
30-60	0.19	0.20	0.22	0.23	0.22	0.21	0.21
60-90	0.26	0.28	0.26	0.27	0.27	0.27	0.27
90-120	0.12	0.11	0.10	0.11	0.12	0.11	0.11
Acacia growing soils							
0-30	0.32	0.31	0.32	0.32	0.30	0.31	0.32
30-60	0.29	0.30	0.27	0.27	0.27	0.27	0.28
60-90	0.12	0.12	0.13	0.12	0.11	0.11	0.12
90-120	0.11	0.12	0.18	0.10	0.12	0.11	0.11

Table (3): Total selenium content, (ppm) in Nkhl soils during the two studied seasons of 2013-2014 and 2014-2015.

Selenium concentration, ppm							
	First season			Second season			
Atriblex growing soils							
Soil depth,(cm)	Site1	Site2	Site3	Site1	Site2	Site3	Average
0-30	0.44	0.46	0.46	0.45	0.44	0.45	0.45
30-60	0.18	0.17	0.19	0.18	0.17	0.18	0.18
60-90	0.27	0.19	0.19	0.18	0.17	0.19	0.18
90-120	0.10	0.11	0.09	0.11	0.10	0.10	0.10
Acacia growing soils							
0-30	0.20	0.19	0.21	0.20	0.19	0.21	0.20
30-60	0.21	0.20	0.20	0.20	0.19	0.20	0.20
60-90	0.17	0.16	0.15	0.15	0.14	0.15	0.16
90-120	0.10	0.11	0.11	0.11	0.10	0.10	0.10

Table (4): Total selenium concentration, (ppm) in the studied soils of inland area of North Sinai Governorate.

Selenium concentration ppm		
Soil depth (cm)	**El-Hassana**	**Nekhl**
Atriplex growing soil		
0-30	0.28	0.45
30-60	0.21	0.18
60-90	0.27	0.18
90-120	0.11	0.10
Acacia growing soil		
0-30	0.32	0.2
30-60	0.28	0.2
60-90	0.12	0.16
90-120	0.11	0.10

Table (5): Water soluble extractable selenium concentration (ppm) in El-Hassana soils during the two studied seasons of 2013-2014 and 2014-2015.

Selenium concentration, (ppm)							
First season				**Second season**			
Atriblex growing soils							
Soil depth,(cm)	**Site1**	**Site2**	**Site3**	**Site1**	**Site2**	**Site3**	**Average**
0-30	0.012	0.012	0.011	0.011	0.010	0.011	0.011
30-60	0.013	0.012	0.010	0.011	0.012	0.012	0.012
60-90	0.010	0.011	0.012	0.012	0.011	0.011	0.011
90-120	0.010	0.010	0.010	0.012	0.010	0.011	0.010
Acacia growing soils							
0-30	0.012	0.010	0.011	0.011	0.010	0.010	0.010
30-60	0.011	0.010	0.012	0.010	0.010	0.011	0.010
60-90	0.012	0.011	0.010	0.010	0.011	0.010	0.011
90-120	0.011	0.010	0.012	0.011	0.010	0.010	0.010

Table (6): Water soluble extractable selenium concentration, (ppm) in Nekl soils during the two studied seasons of 2013-2014 and 2014-2015.

Selenium concentration, (ppm)							
	First season			Second season			
Atriblex growing soils							
Soil depth,(cm)	Site1	Site2	Site3	Site1	Site2	Site3	Average
0-30	0.018	0.018	0.019	0.019	0.018	0.018	0.019
30-60	0.012	0.012	0.010	0.011	0.013	0.013	0.012
60-90	0.010	0.010	0.011	0.012	0.011	0.011	0.011
90-120	0.011	0.011	0.012	0.010	0.011	0.011	0.011
Acacia growing soils							
0-30	0.011	0.011	0.012	0.011	0.011	0.011	0.011
30-60	0.011	0.012	0.011	0.011	0.011	0.011	0.011
60-90	0.013	0.012	0.012	0.013	0.012	0.012	0.013
90-120	0.012	0.011	0.011	0.011	0.011	0.011	0.011s

Table (7): Water soluble extractable Selenium concentration, (ppm) in the studied soils of inland area of North Sinai Governorate.

Selenium concentration ppm				
	Location			
Soil depth (cm)	El-Hassana	(%) of total	Nekhl	(%) of total
Attriplex growing soil				
0-30	0.011	3.92	0.019	4.22
30-60	0.012	5.71	0.012	6.66
60-90	0.011	4.07	0.011	6.11
90-120	0.010	9.09	0.011	11.00
Acacia growing soil				
0-30	0.010	3.12	0.010	5.00
30-60	0.010	3.57	0.010	5.00
60-90	0.011	9.16	0.013	8.12
90-120	0.010	9.09	0.010	10.00

Selenium concentration in soil solution may be abettor indicator for defining Se deficiency than the soil total Se. In low Se soils, the solution Se concentration could be as low as 2 ppm or about 1-2% of the soil Se.

In Se adequate soils, soluble Se concentrations about 4-6% of the soil Se or as high as 18 ppm. There is a correlation between the concentrations of Se in soil solution and the Se concentration in plant.

Only some of the Se found in soil solutions is bio available to plants. Generally, 45% of the soluble Se in soil solutions can be utilized by plants or about 0.5-1.0% of soil Se in low Se soils is available for plant uptake in an situ experiment, using ^{75}Se as a tracer, it was estimated that about 0.2-1.3% of the soil Se can be available for plant **(Li and Zhong, 1990).**

On the other hand, selenium extracted with DTPA solution in Tables 8, 9 and 10 varied from 0.011 to 0.018 ppm. In El-Hassana studied soils, the percent extraction values ranged from 4.07% to 15.45%.

The low percent extraction values may indicate that the total selenium in the soil are present in low soluble forms and could not easily convert to available form to plant.

Obtained results cleared also that there are appositive correlations between the previous extracted selenium using the two three studied extracting agents and the content of selenium in the studied range plants.

Obtained results in Tables 11, 12 and 13 indicate that the concentrations of $CaCl_2$ extractable selenium from the two studied soils.

The extractable selenium using the previous extracting agent ranged from 0.011 to 0.018ppm in El-Hassana soils comparing to 0.014 and 0.018 ppm in Nekhl soils. The percent extraction values varied between 3.92% and 16.36% in El-Hassana soil comparing to 4.00% and 17.00% in Nekhl soils.

Selenium Content of Studied Rang Plants

Obtained results in Table 14 indicated that the selenium content in atriblex plant was higher than that in acacia plant in both two studied locations. It of interest to mention that both studied plants contain selenium higher than required by grazing animal (0.1 ppm). The content of selenium in atreblex range plant ranged between 2.90 and 2.93 ppm in El-Hassana studied location comparing to 2.86 ppm and 2,88ppm in Nekhl location.

The corresponding values for acassia range plant varied between 0.17 and 0.18 ppm in El-Hassana location comparing to 0.17 and 0.19 ppm in Nekhl studied location. Wild grasses grown under grazing regions, North Western part of Egypt, contain the highest selenium content. Consequently, it may be concluded that animals in these regions are not subjected to Se deficiency since their diets consist of different herbaceous plants belonging to miscellaneous families. These different families contain either higher or lower selenium content than the recommended limit (0.1ppm) and this may lead to somewhat balance in the animal diet **(Abdellah, 1983).** Similar findings were obtained by **Ismil (2009)** with respect to atreblex range plant in the North Western coast of Egypt.

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Table (11): $CaCl_2$ extractable selenium concentration, (ppm) in El-Hassana soils during the two studied seasons 2013-2014 and 2014-2015.

Selenium concentration, ppm							
	First season			Second season			
Atriblex growing soils							
Soil depth,(cm)	**Site1**	**Site2**	**Site3**	**Site1**	**Site2**	**Site3**	**Average**
0-30	0.016	0.017	0.016	0.017	0.016	0.017	0.017
30-60	0.014	0.015	0.016	0.015	0.016	0.015	0.015
60-90	0.017	0.016	0.017	0.016	0.016	0.017	0.017
90-120	0.015	0.014	0.016	0.015	0.016	0.015	0.015
Acacia growing soils							
0-30	0.016	0.014	0.015	0.016	0.015	0.015	0.015
30-60	0.010	0.012	0.010	0.011	0.010	0.010	0.0111
60-90	0.019	0.019	0.017	0.018	0.017	0.019	0.018
90-120	0.018	0.019	0.019	0.019	0.017	0.017	0.018

Table (12): $CaCl_2$ extractable selenium concentration, (ppm) in Nekhl soils during the two studied seasons of 2013-2014 and 2014-2015.

Selenium concentration, (ppm)							
	First season			Second season			
Atriblex growing soils							
Soil depth, (cm)	**Site1**	**Site2**	**Site3**	**Site1**	**Site2**	**Site3**	**Average**
0-30	0.018	0.017	0.019	0.018	0.017	0.018	0.018
30-60	0.014	0.015	0.016	0.013	0.014	0.014	0.014
60-90	0.015	0.014	0.016	0.015	0.016	0.015	0.015
90-120	0.040	0.016	0.015	0.014	0.015	0.015	0.016
Acacia growing soils							
0-30	0.016	0.017	0.015	0.014	0.015	0.015	0.016
30-60	0.015	0.014	0.016	0.013	0.014	0.014	0.014
60-90	0.014	0.015	0.016	0.015	0.016	0.015	0.015
90-120	0.017	0.016	0.016	0.016	0.017	0.017	0.017

Table (13): $CaCl_2$ extricated Se concentration, ppm in the studied soils of inland area of North Sinai Governorate.

Selenium concentration ppm				
Location				
Soil depth cm	El-Hassana	% of total	Nekhl	% of total
Attriplex growing soil				
0-30	0.017	6.07	0.018	4.00
30-60	0.015	7.14	0.014	7.77
60-90	0.017	6.29	0.015	8.33
90-120	0.015	13.63	0.016	16.00
Acacia growing soil				
0-30	0.015	4.68	0.016	8.00
30-60	0.011	3.92	0.014	7.00
60-90	0.018	15.00	0.015	9.37
90-120	0.018	16.36	0.017	17.00

Table (14): Selenium concentration ppm in the two studied rang plants during the two seasons of 2013-2014 and 2014-2015 in both El-Hassana and Nekhl.

Selenium concentration ppm									
Location									
El-Hassana					Nekl				
Atriblex plant									
Seasons	$Site_1$	$Site_2$	$Site_3$	Average	$Site_1$	$Site_2$	$Site_3$	Average	
2013-2014	2.90	2.93	2.91	2.91	2.86	2.87	2.88	2.87	2.87
2014-2015	2.90	2.92	2.91		2.86	2.86	2.87		
Acacia plant									
2013-2014	0.16	0.17	0.18	0.17	0.18	0.19	0.18	0.18	0.18
2014-2015	0.17	0.18	0.17		0.19	0.18	0.17		

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الملخص العربي

موقف عنصر السيلينيوم في بعض الأراضي بشمال سيناء

٢. المنطقة الداخلية

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يعتبر السيلنيوم من العناصر النادرة الضرورية للحيوان الانسان وحيث يعتبر النبات المصدر الرئيسي لامدادهما بذلك العنصر الذي لم يثبت حتي الآن ضروريته للنبات في مناطق الرعي المفتوح تعتبر النباتات الرعوية المصدر الرئيسي لإمداد الحيوان بذلك العنصر ومن هنا تتضح أهمية دراسة حالة ذلك العنصر في التربة خاصة في المناطق الداخلية البعيدة عن البحار حيث تعتبر تلك البحار أحد أهم مصادر السيلينيوم في التربة خاصة الطبقات السطحية منها. من خلال مياه الامطار wet deposition أو الـ Aerosols الناشئة عن مياه البحار. أشارت عديد من الابحاث إلي وجود آلية أخري في المناطق الداخلية Inland البعيدة عن البحار وذلك من خلال ما يسمي Dry pricipittion أو الترسيب الجاف أو العواصف الترابية حيث تعتبر هذه الالية أحد أهم طرق امداد التربة بذلك العنصر من خلال النقل من المناطق الساحلية إلي المناطق الداخلية ويمثل مركزي الحسنه ونخل المناطق الداخلية من محافظة شمال سيناء، حيث أجري هذا البحث خلال موسمي ٢٠١٣-٢٠١٤و٢٠١٤-٢٠١٥. تم تحديد ٣ مواقع حيث ينمو نباتي الاتربلكس والاكاسيا في كل من مركزي الحسنه ونخل وأخذت عينات تربة من أعماق صفر، ٣٠، ٣٠، ٦٠، ٦٠، ٩٠، ٩٠، ١٢٠ سم. أخذت عينات نباتية من نباتي الاتربلكس والاكاسيا (الأوراق) وذلك خلال شهر ابريل في الموسمي سابقي الذكر. تم تقدير الخواص الطبيعية والكيميائية وكذلك تم تقدير كل من السيلينيوم الكلي والسيلينيوم المستخلص بواسطة كل من الماء، كلوريد الكالسيوم، DTPA من التربة. كذلك تم تقدير محتوي السيلينيوم في الأوراق من النباتين الذكورين. وكانت أهم النتائج ما يلي: أظهرت النتائج أن محتوي التربة من السيلينيوم الكلي اختلف بين موقعي الدراسة، حيث تراوح بين ٠,١١ ppm، ٠,٣٢ ppm في أراضي الحسنه، بينما كانت القيم المقابلة في أراضي نخل بين ٠,٤٥ ppm، ٠,١٥ ppm، كانت أعلي قيم لتركيز السيلينيوم في الطبقة السطحية في كل موقعي الدراسة وانخفضت تلك التركيزات مع العمق. وحيث أن تلك القيم كانت أعلي من التوسط العام لمحتوي السيلينيوم في القشرة الأرضية ٠,٠٨٣ ppm فإن هذا ربما يشير إلي أن المنشأ الخارجي لهذا السيلينيوم والذي قد يرجع إلي ما يسمي الترسيب الجاف Dry deposition أي الترسيب الجاف من خلال نقل الحبيبات الناعمة خلال العواصف الترابية من المناطق الساحلية التي تحتوي الطبقة السطحية لها عن تركيزات عالية نسبياً من السيلينيوم ذو المنشأ البحري، أوضحت النتائج اختلاف مقدرة المستخلصات الثلاث المستخدمة في البحث في مقدرتها علي استخلاص السيلينيوم حيث تراوح تركيز السيلينيوم في حالة الماء بين ٠,٠١ ppm، ٠,١٩ ppm نسبة مئوية للاستخلاص بين ٣,١٢% و١٠%، تراوح تركيز السيلينيوم المستخلص بواسطة محلول DTPA بين ٠,٠١ ppm، ٠,٢٢ ppm نسبة استخلاص بين ٧,٠٤% و١٧% وفي حالة الاستخلاص بواسطة محلول كلوريد الكالسيوم كانت القيم ٠,٠١١ وأعلي قيمة ٠,٠٨٣ في كل الأراضي تحت الدراسة بنسبة استخلاص ٣,٩٣ إلي ١٧%. وتشير هذه النتائج إلي أن السيلينيوم المستخلص في الحالات الثلاث منخفض جداً مما يشير إلي أهمية عدم الاعتماد علي تقدير الصورة الكلية للعنصر عند تحديد موقفه في الأراضي؛ بل لابد من الاعتماد علي الصور المستخلصة بالمستخلصات المختلفة حيث تشير النسبة المئوية المنخفضة للاستخلاص إلي أن معظم السيلينيوم في الصورة الكلية يكون في صورة قليلة الذوبانية جداً وقليلة الصلاحية للنبات، وكما أظهرت النتائج أن محتوي نبات الاتربلكس من السيلينيوم تراوح بين ٢,٨٧ ppm، ٢,٩١ ppm، بينما كان تركيز السيلينيوم في نبات الاكاسيا بين ٠,١٧ ppm، ٠,١٨ ppm. وفي كلا الحالتين كانت تركيزات السيلينيوم في النباتين تحت الدراسة أعلي من الحد الأدني المطلوب للحيوان من السيلينيوم (٠,١ جزء في المليون).

الكلمات الاسترشادية: عنصر السيلينيوم، الأراضي، شمال سيناء، المنطقة الداخلية.

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