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Simultaneous determination of some elements in Suaeda aegyptiaca by ICP- OES

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ABSTRACT

Background:In this study concentrations of some elements Na, K, Mg, Ca, Al, Mn, Fe, Co, Cr, and P were determined in leaves and stems of Suaeda aegyptiaca by Inductively Coupled Plasma Optical Emission Spectrometry (ICP OES) after microwave-assisted acid digestion. The limit of detection (LOD) of method obtained below 8 ng kg-1 and the relative standard deviations were below 6% . Recovery studies for all elements were found to be 89% and 105%, and the linear correlation coefficients for as inductively coupled plasma optical emission spectrometry (ICP OES) were R=0.999. A new and simple procedure, high extraction efficiency, short analysis time, and inexpensive components describe the high potential of the proposed method for routine metal analysis in halophytes samples.

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INTRODUCTION

Halophytes, representing ~1% of the world's flora, are plants that can grow and complete their lifecycles in environments with high concentrations (greater than 200 mM) of electrolytes (mostly $Na^+$and Cl^-, but also SO_4^{2-}, Mg^{2+}, Ca^{2+}, K^+ and CO_3^{2-}) in the root medium. Halophytes are plants that have the ability to live in saline and alkaline soils and can resist against drought and they can store inorganic ions and produce a high osmotic potential to absorb water. Some halophytes are also compatible to live in immersion regions with saline water ,for example coastal salt [1-2]. There are 26 families of halophytes species in Iran and more than 70% of them has belonged to the Chenopodiaceae family[3-4].

Most samples are not suitable for direct introduction into analytical instruments. For this reason, the sample preparation procedure is an important step in an analytical study. Several analytical techniques, such as Inductively Coupled Plasma Optical Emission Spectrometry (ICP OES), Inductively Coupled Plasma Mass Spectrometry (ICP-MS), Flame Atomic Absorption Spectrometry (FAAS) and Electrothermal Atomic Absorption Epectrometry (ET AAS) for determining some element concentration in food samples[5–13].

ICP OES that can provide a rapid and proper program for multi element analysis [5]. The microwave-assisted acid digestion, usually very simple and fast analysis to the complete decomposition and accurate determination of elements in food samples followed by an ICP OES or ICP-MS [14-21]. The main objectives of the present study to determine of concentration elements in leave and stem of halophytes by ICP OES. Finally to the best of our knowledge there are no published research studies about determination of elements in halophytes. The method successfully was applied to determine some elements in the *S. aegyptiaca* samples.

Experimental:
Instrumentation:

The concentrations of elements contain, Na, K, Mg, Ca, Al, Mn, Fe, Co, Cr, and P were determined in halophytes samples by Inductively Coupled Plasma Optical Emission Spectrometer ICP OES (Varian 730-ES Axial ICP-OES) and Argon (99.99%) as carrier gas and samples digestion was carried out in a microwave oven, Milestone MLS 1200 Mega model (Sorisole, Italy).Instrumental parameters are showen in table 1.

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Materials and reagents:

All reagents were used analytical grade and were purchased from Merck (purity higher than 99%) . Water used in all the experiments was Ultrapure water. High purity Ultrapure water was obtained from Millipore, Milli-Q (Bedford, MA, USA). A calibration curve was prepared for each metals and the correlation coefficient based on the concentration curve was >0.999. All the stock solutions and working standards were stored at 4 C^0 and brought to room temperature (25C^0) before use.

Sample Preparation and digestion procedure:

The present study was carried out on commonly used halophytes, *S.aegyptiaca* in three different region of Dashti,Busher Province in Iran early summer 2013. The collected samples were dried after separating leaves and stems, then rinsed with distilled water.

The samples were macerated and homogenized in an agata mortar and subsequently around 0.5 g was weighed directly on polytetrafluorethylene (PTFE) flasks after adding 3 mL of HNO_3 and 1 mL of H_2O_2, the mixture was subjected to a digestion program: 100 W(4 min), 0 W(2 min), 250 W(2 min), 0 (4 min), 500 W(2 min), 0 W(2 min), 400 W(2 min), 0 W (4 min) and 450 W (2.5 min). This digestion program was applied twice in order to guarantee the total decomposition. Finally concentration Na, K, Mg, Ca, Al, Mn, Fe, Co, Cr, and P contents were determined using ICP-EOS. Features of the sample preparation method include:(a) microwave assisted dissolution of the samples (b) addition of 4 mL HNO_3(6 M) and 1 mL of H_2O_2(1 M) and (c) ultrasonic 20°C and of 3 min, filtration and dilution of the solution to a predetermined volume before being subjected to analysis by ICP-OES.

RESULTS AND DISCUSSION

Method evaluation:

The limit of detection (LOD) was three times the standard deviation of 10 measurements of blank divided by the slope of the calibration curve. LOD was found to be less than 8 mg kg^{-1}. The precision as estimated by relative standard deviation was less than 6%. The calibration curves for analytes over the desired concentration ranges exhibited good linearity. The linear correlation coefficient for ICP OES was 0.999. Recovery studies for all elements were performed in *S.aegyptiaca* at concentration levels of 5,50, 100 mg kg^{-1} and were found to be 89% and 104%. The figures of merit for the some elements are shown in Table 2.

Application of the proposed method to real sample:

To evaluate performance of the proposed method for determination of some elements samples were carried out under conditions that mentioned above. The concentration of elements in leaves and stems *S.aegyptiaca* has been shown in table 3. The recovery of spiked samples is satisfactory reasonable and was confirmed using standard addition method, which indicate the capability of the proposed method for the determination of amounts of elements in halophyte samples. Accuracy data elements for spiked in real sample are shown in Table 4,5.

Discussion:

The proposed method has been applied to the determination of elements in *S. aegyptiaca*. The Na ion content for all species was higher than K, Mg, Ca, Al, Mn, Fe, Co, Cr, and P. Chenopodiaceae family grows under high Na concentration. Asri et al in 1997 studied minerals of halophytes and concluded that accumulation of Na is higher than K, Ca and Mg in halophytes. The results of the present study are consistent with the result of Asri. Asri et al in 1997 studied minerals of halophytes and concluded that accumulation of Na is higher than K, Ca and Mg in halophytes [22].

Riasi et al (2008) studied four halophytes and found that Na, K and Cl in these plants were above critical level, while Ca and Mg concentrations were below the critical level [23]. The leaves of plant have been used as medicine for hepatitis traditionally. It is reported to possess antiviral, antibacterial activity and antioxidant activity etc. The mineral elements in halophytes are significantly changed during growth in different weather conditions. The halophytes have the mechanisms that can adapt and select the critical ions from the soil. These ions are different in various regions and also in different organs of plant. The evaluation of element composition of various extracts in *S. aegyptiaca* can be used to achieve the levels and of importance of ions in different weather conditions and also to achieve which organs of plant can be used to prepare an extract of important and usefull ions for use in human.

Conclusions:

In this study concentrations of some elements, Na, K, Mg, Ca, Al, Mn, Fe, Co, Cr, and P were determined in leaves and stems of *S. aegyptiaca* in three different region of south of Iran by ICP OES after microwave-assisted acid digestion. ICP OES and ICP-MS techniques were demonstrated to be suitable for element determinations in *S. aegyptiaca* samples following micro-wave assisted acid digestion. The samples are conveniently smashed and homogenized in an agata mortar, avoiding oil loss before digestion. A clear transparent solution was obtained after running the power program twice, important and usefull ions for use in human. The evaluation of element composition of various *S. aegyptiaca* can be used to achieve the levels and of importance of ions in different weather conditions and also to achieve which organs of plant can be used to prepare an extract of important and usefull ions for use in human. The leaves of plant have been used as medicine for hepatitis traditionally. It is reported to possess antiviral, antibacterial activity and antioxidant activity etc.

Table 1: Instrumental conditions of the ICP OES.

Parameter	Value
RF incident power	1.3 kW
Plasma argon flow rate	15 L min^{-1}
Auxiliary argon flow rate	1.5 Lmin^{-1}
Nebulizer	V-groove
Gas	Ar 99.999%
Sample aspiration rate	2 mL min^{-1}
Background correction	Fixed point
Number of replicates	3
Torch	Quartz for axial view

Table 2: Figures of merit for the determination of elements by ICP OES.

Element	r2	LOD ($mgkg^{-1}$)	Linear rang ($mgkg^{-1}$)	RSD (%)
Na	0.9993	4.7	5-250	1.1
K	0.9994	7.2	10-500	4.2
Mg	0.9997	5.3	5-500	2.3
Ca	0.9995	5.7	10-1000	2.6
Al	0.9992	5.3	50-500	2.5
Cr	0.9991	6.8	10-500	3.8
Mn	0.9992	4.3	5-250	5.9
Co	0.9995	5.9	5-500	2.3
P	0.9997	5.8	50-250	4.2

Table 3. Concentration analysis of elements in samples by ICPOES (n=3).

Element	Wavelength (nm)	Suaeda aegyptiaca[1] ($mgkg^{-1}$)	Suaeda aegyptiaca[2] ($mgkg^{-1}$)
Na	588.995	2218±1.29	2149±1.31
K	796.897	1456±0.35	1960±2.14
Mg	279.809	1433±1.24	1684±1.18
Ca	315.887	465±0.98	290±1.39
Al	396.152	115±1.46	119±0.25
Cr	267.716	78±0.94	61±0.36
Mn	257.615	91±2.19	82±0.19
Co	238.892	38±2.27	64±0.33
P	177.434	421±1.12	534±0.49

1. .leaves 2. stems

Table 4: Accuracy data elements for spiked in leaves of *S.aegyptiaca*.

Real Sample[1]	Added ($mgkg^{-1}$)	Found ($mgkg^{-1}$)	Recovery (%)
Na	50	45.5	91
	100	97	97
K	50	47.51	95
	100	90	90
Mg	50	49	98
	100	104	104
Ca	50	48.6	97
	100	100	100
Al	50	50.5	101
	100	89	89
Cr	50	47	94

	100	95	95
Mn	50	50.1	100
	100	105	105
Co	50	48.9	98
	100	99	99
P	50	48.6	97
	100	103	103

1.leaves of aegyptiaca

Table 5: Accuracy data elements for spiked in stems of *S.aegyptiaca*.

Real Sample[1]	Added (mgkg-1)	Found (mgkg-1)	Recovery (%)
Na	5	4.9	96
	100	99.2	99
K	5	4.5	96
	100	102	102
Mg	5	4.8	96
	100	103	103
Ca	5	4.8	96
	100	98	98
Al	5	4.6	92
	100	96	96
Cr	50	51	102
	100	100	100
Mn	5	5.2	104
	100	99	99
Co	5	5.2	104
	100	97.9	98
P	5	4.7	94
	100	101.8	102

1.stems of *S.aegyptiaca*

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