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Determination the Concentration Elements of Cultivation Media (Peat Moss, Perlite and Hormone) Using X-ray Fluorescence Technique

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Abstract

The concentration of elements were analyzed of twelve cultivation medium (Peat moss, Perlite and Hermon) selected from Iraqi markets using X-ray fluorescence techniques. The analytical results show that the cultivation medium contained high concentration of (Na, Al, Si, S, K, Ca, Fe) and low concentration of (Mg, P, Cl, Ti, V, Cr, Mn, Co, Ni, Cu, Zn). The samples also contained trace concentration of (Ge, As, Se, Br, Sr, Y, Mo, Cd, I, Hg, Pb, U). The results were compared using atomic absorption spectrophotometric technique for measuring the concentration of (K, Ca, Cu, Mn, Zn, Pb).

The Results showed that there is significant difference in the concentration of each element in most of the samples. The concentrations of elements are in threshold levels except few elements such as aluminum. The Cd concentration was higher than the limit in some samples. To purpose of evaluating the precision of the analysis results, calculated the standard deviation SD and relative standard deviation, it was found in the range of (0.004561-0.328634) %, (1.09-19.23) % and accuracy was found in the range of (0.27-44.32) %.

Keywords: X-Ray fluorescence (XRF); Toxic elements; Peat Moss.

تحديد تركيز العناصر لأوساط زراعية (البيتموس و بيرلايت و الهرمون) باستخدام تقنية فلورة الاشعة السينية

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الخلاصة

استخدمت تقنية فلورة الاشعة السينية لايجاد تركيز العناصر لاثني عشر نموذجا من الأوساط الزراعية (البيتموس و بيرلايت و الهرمون) المختارة من الاسواق المحلية. اظهرت النتائج ان وسط الزراعة يحتوي على تراكيز عالية من (الصوديوم والالمنيوم والسيليكون والكبريت والبوتاسيوم والكالسيوم والحديد) وتراكيز منخفضة من (المغنيسيوم والفسفور والكلور والتيتانيوم والفناديوم والكروم والمنغنيز والكوبلت والنيكل والنحاس والزنك) وتراكيز قليلة جدا من (الجرمانيوم والزرنيخ والسيلينوم والبروم والسنترونتيوم واليتريوم والمولبدنوم والكادميوم واليود والزئبق والرصاص واليورانيوم) وتمت مقارنة النتائج لتراكيز العناصر (البوتاسيوم والكالسيوم والنحاس والمنغنيز والزنك والرصاص) باستخدام تقنية مطيافية الامتصاص الذري. اظهرت النتائج وجود فرق بسيط لتركيز كل عنصر للنماذج المختارة، كما اوضحت النتائج ان معظم تراكيز العناصر ضمن الحدود المقررة

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باستثناء بعض العناصر مثل الالمنيوم. كما اوضحت النتائج ان تركيز الكادميوم اعلى من الحدود المقررة لبعض من النماذج. ولغرض تقييم توافق نتائج التحليل تم حساب الانحراف المعياري والانحراف المعياري النسبي وكانت قيمهما تتراوح بين(0.004561–0.328634)% و (10.9–19.23)%. اما دقة النتائج فتتراوح بين (44.32–0.27)%.

Introduction

Cultivation medium such as peat moss, perlite and hermon used as a soil conditioner which increases the soil's capacity to hold water, nutrients, improve aeration and modify the soil substructure [1]. Some trace elements are important in the nutrition of plant and animals or humans (e.g. Cu, Cd, Zn, Mn, Ni, V). The others are known to possess virtually negative nutritional effect (e.g. Pd, Cd and Hg). All these trace elements over large territories and long time periods may cause gradual damage for organisms which now necessitate careful assessment of their input [2, 3].

Now a days several advanced instrumental method such as inductively coupled plasma-atomic emission spectrometry (ICP-AES), inductively coupled plasma-mass spectrometry (ICP-MS), graphite furnace atomic absorption spectrometry (GFAAS), laser-induced breakdown spectroscopy and flame atomic absorption spectrometry (FAAS) was used by many groups to determine the elements in fertilizers [4-9].

Several groups were used X-ray fluorescence technology (ED-XRF) due its one of the simplest, accurate and most economic analytical methods for the determination the samples concentration of many types of materials. It is non-destructive and reliable, required very little sample preparation, suitable for solid, liquid and powdered samples. It can be used for a wide range of elements, from sodium (11) to uranium (92) and provides detection limits at the sub-ppm level. It can also measure concentrations easily and simultaneously [10].

The objective of this work is to identify the concentration elements of twelve selected samples of peat moss, perlite and hermon, and studying their impact on the quality and quantity of the product. Previous studies had shown for the presence and concentration of various elements in different plant depending on the composition of the soil, water and fertilizers used as well as permissibility, selectivity and absorbability of plants for the uptake of these elements [11].

Material and Methods

Samples Materials

Different cultivation media samples were collected from the Iraqi markets (eight of them are peat moss, one of perlite and the other are hormones), shown in (Table-1).

Table 1-The cultivation medium with the sample code

Cultivation medium	Sample Type	Sample code
Peat moss Iraqi	Peat moss	S1
Peat moss FIAFI Iraqi	Peat moss	S2
Peat moss originality Iraqi	Peat moss	S3
Peat moss Green&fresh55	Peat moss	S4
Peat moss Chiftcliler turkey	Peat moss	S5
Peat moss Pot grand universal	Peat moss	S6
Peat moss Pot grand Holand	Peat moss	S7
Peat moss Green land Italy	Peat moss	S8
Iraqi hormone	hormone	S9
perlite Saudi	perlite	S10
Spanish hormone	Hormone	S11
Holand hormone	Hormone	S12

X-ray florescence analysis

Pretreatment of samples

The selected samples were weighted in the range of 400-500 gm. Then samples were dried at 200 ^{o}C for 30 minute in drying oven. The dried samples were crushed using a ball milling unit. The result powder were fine with a homogenous particle size, this process ensures the minimizing of the matrix effect error. Each sample was pressed via hydraulic piston with pressure of 15 Ton/cm^2 and a diameter of tablets are 32 millimeter.

Procedure for sample analysis

The samples were analyzed using the SPECTRO XEPOS XRF unit with silicon drift lithium detector with resolution 45eV at 5.9 keV of the iron isotope 55Fe [12]. This detector does not need liquid nitrogen for cooling. It has a source as a tube form with beryllium window using three targets that covers a wide range of X-ray energies. These targets are highly oriented pyrolytic graphite (HOPG), alumina (Al_20_3) and Molybdenum. The system is using vacuum to get more efficiency of analysis especially for light elements [13, 14].

Atomic Absorption Spectrophotometer (AAS) Analysis

Nine samples were selected .The samples were crushed using agate mortar to become homogenous. One gram was separately weighed into 100 ml glass-boiling test tube. Then it was added de-ionized water and digested at 80^{o}C using (1.5) ml concentrated hydrochloric acid and (5) ml of Nitric acid. The samples were gradually brought to boil for four hours, after that cooled, filtered and diluted to 100ml volume with de-ionized water. The samples were analyzed using the Analytika Jeua NOV 400 Atomic Absorption Spectrometer (AAS).

Results and Discussion

To identify the accuracy, the standard sample [PCC-1] was measured and comparison the results with the published in certificate data .The range of accuracy is from 0.27% to 44.32% as shown in Table-2.

Table 2-The comparison of results between experimental data and the results published in certificate data to [PCC-1].

No	A. N	E.S	Con*	Con**	Error%	No.	A. N.	E.S.	Con.*	Con.**	Error%
1	11	Na	0.340	0.360	5.55	8	19	K	8.012	8.00	0.27
2	12	Mg	28.80	28.190	2.16	9	20	Ca	0.22	0.272	26.47
3	13	Al	0.320	0.350	8.57	10	24	Cr	0.021	0.031	32.25
4	14	Si	20.690	19.480	6.21	11	25	Mn	0.517	0.5	3.4
5	15	p	0.380	0.400	5.00	12	26	Fe	1.804	1.25	44.32
6	16	S	0.145	0.144	0.69	13	28	Ni	0.349	0.372	5.94
7	17	Cl	0.761	0.875	13.03	14	30	Zn	1.64	1.87	12.42

A. N.: atomic number, E.S.: element symbol, Con*: The experimental concentration, Con**: The certificate concentration

To calculated the standard deviation and relative standard deviation, the same standard sample was measured and repeated five times. The range is from (0.004561 to 0.22786), and (1.09 to 19.23) respectively as shown in Table-3.

The measurement of the accuracy and standard deviation showed that the X-ray fluorescence system is important for such studies as shown in Figures-(1, 2, 3, 4). Figure-5 shown the FIAFI sample spectrum.

Table 3-The calculated of standard and relative standard deviation

Element	*Con/certificate %.	Con/1 %	Con/2 %	Con/3 %	Con/4 %	Con/5 %	Con/av. %	S.D. %	R.S.D. %
Na	0.36	0.34	0.31	0.35	0.29	0.32	0.322	0.023875	7.42
Mg	28.19	28.9	28.5	28.9	28.3	28.2	28.56	0.328634	1.15
Al	0.35	0.32	0.31	0.29	0.35	0.29	0.312	0.0249	7.98
Si	19.48	20.69	20.91	20.42	21.01	20.81	20.768	0.22786	4.81
p	0.40	0.38	0.36	0.32	0.41	0.42	0.378	0.040249	10.58
S	0.144	0.145	0.15	0.16	0.13	0.12	0.141	0.015969	10.63
Cl	0.875	0.761	0.78	0.81	0.69	0.77	0.7622	0.044376	5.789
K	8.00	8.012	8.22	8.41	8.19	7.91	8.1484	0.194121	2.38
Ca	0.272	0.22	0.21	0.25	0.18	0.23	0.218	0.025884	11.92
Cr	0.031	0.021	0.019	0.023	0.023	0.031	0.0234	0.004561	19.23
Mn	0.5	0.517	0.521	0.499	0.51	0.5	0.5094	0.009864	1.92
Fe	1.25	1.804	1.83	1.84	1.83	1.86	1.8328	0.020229	1.09
Ni	0.372	0.349	0.37	0.32	0.35	0.36	0.3498	0.018714	5.34
Zn	1.87	1.64	1.7	1.59	1.55	1.68	1.632	0.062209	3.69

*Con : concentration

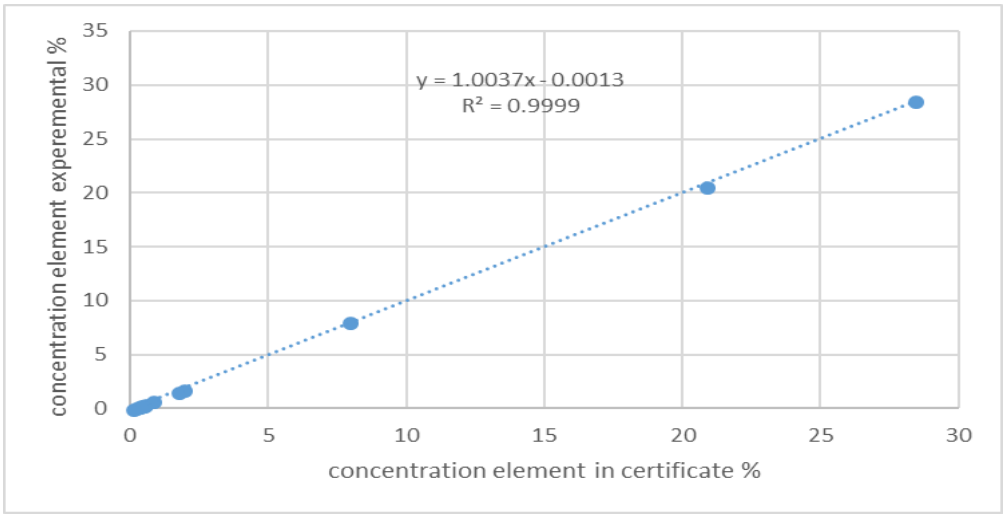

Figure 1-The relationship between the certificate and experimental concentration elements.

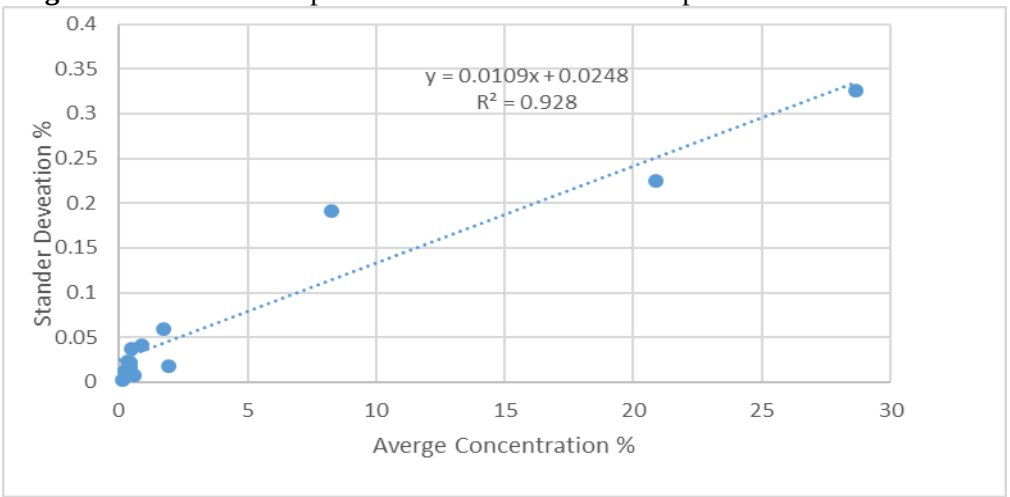

Figure 2- The relationship between stander deviation and average concentration.

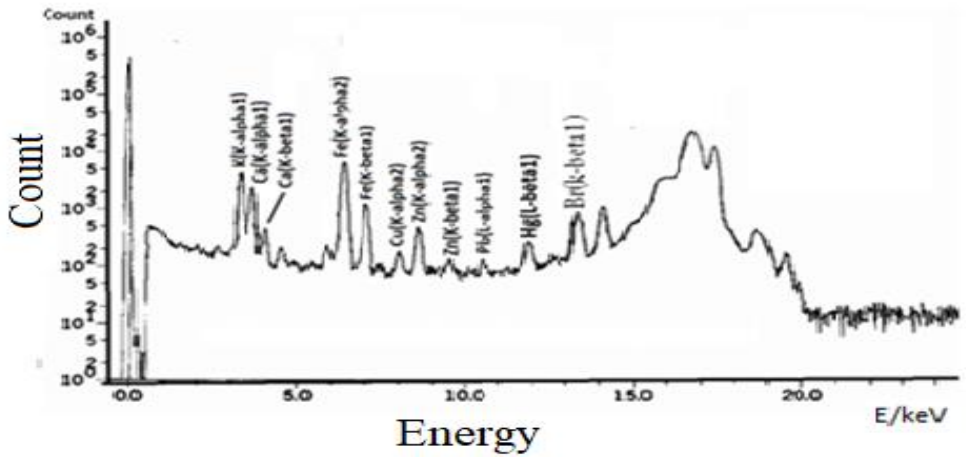

Figure 3-The spectrum of FIAFI Iraq using HOPG target.

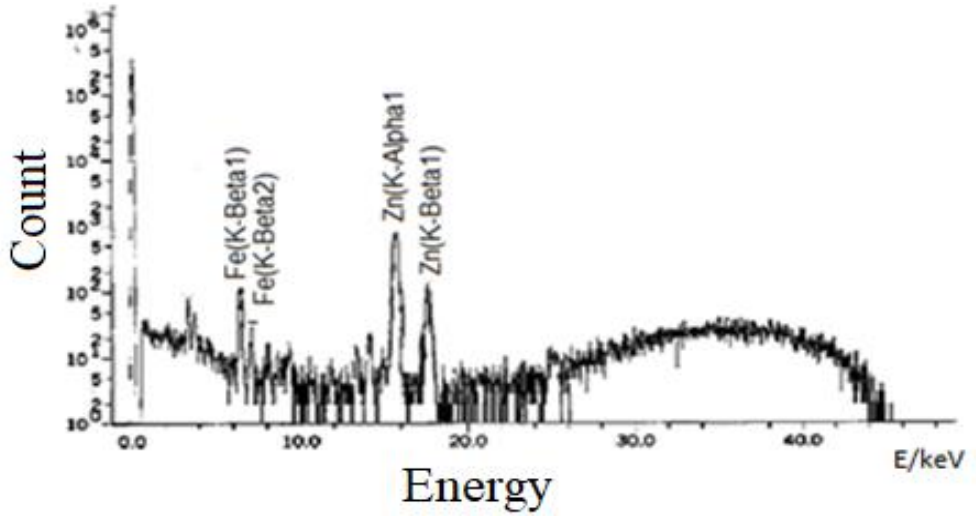

Figure 4-The spectrum of FIAFI Iraq using Al203 target

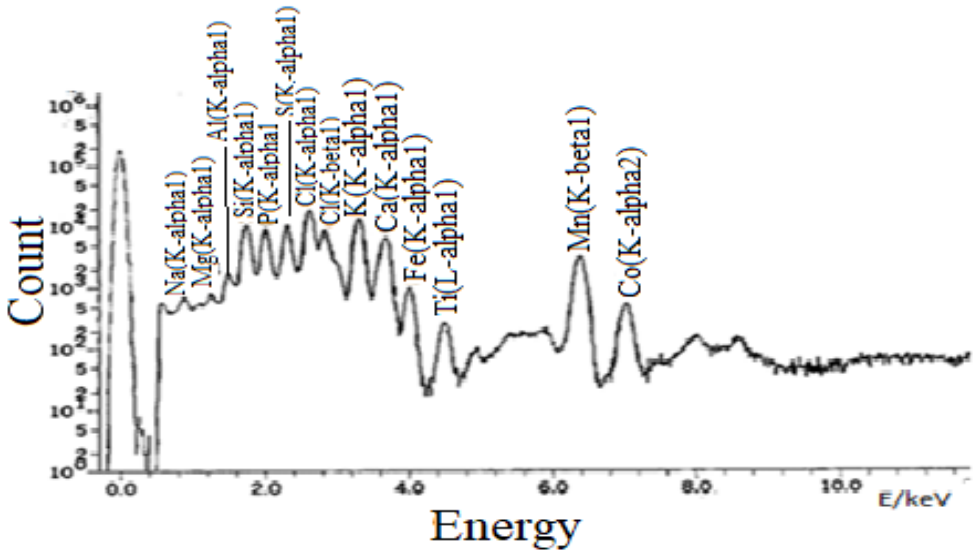

Figure 5-The spectrum of FIAFI Iraq using Molybdenum target

The concentration of elements twelve cultivation medium was determined by X-ray fluorescence method. The concentration of major elements (Na, Al, Si, S, K, Ca, Fe).

The highest concentration in most samples is calcium and then iron, silicon, potassium and sodium.

Cultivation medium contain different levels in most of the major elements is shown in Figure-6. The range concentration of aluminum is from 0.0007±0.0% to 0.83±0.004%. Though Al is the most abundant element in the earth crust it. However it is not an essential element needed for plant growth. Al toxicity in human is associated with loss of memory and dementias. Al concentration in cultivation medium should be monitored the danger of high concentrations of Aluminum in cultivation medium is not only its toxicity but its ability to replaced strontium which can then replace calcium [15].

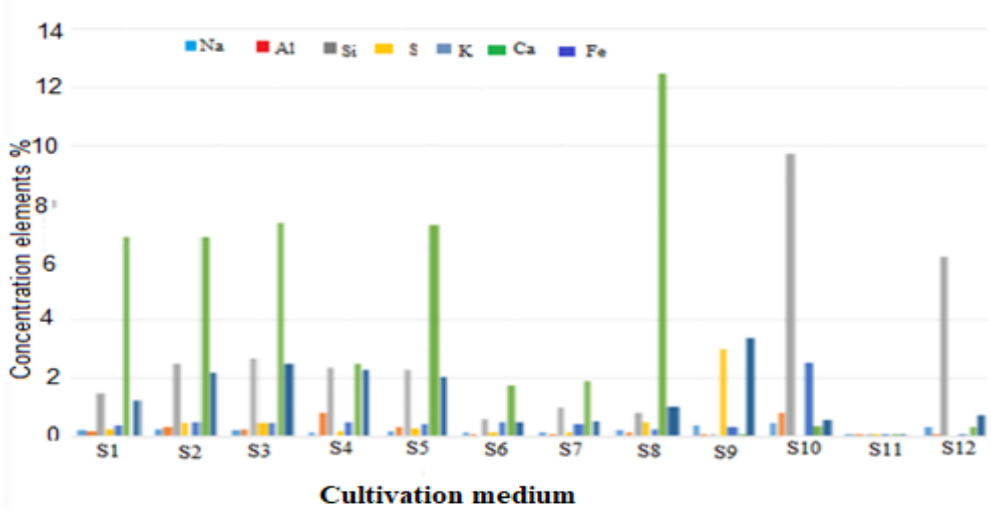

Figure 6-The concentration elements of (Na, Al, Si, S, K, Ca, Fe) % using XRF

Figures-(7, 8) show the concentration of each minor elements (Mg, P, Cl, Ti, V, Cr, Mn, Co, Ni, Cu, Zn) in all samples significantly different. Each element has significance in plant growth the lack of zinc affects the size shape of the cells and the evolution of plant. Copper is essential in the process of photosynthesis.

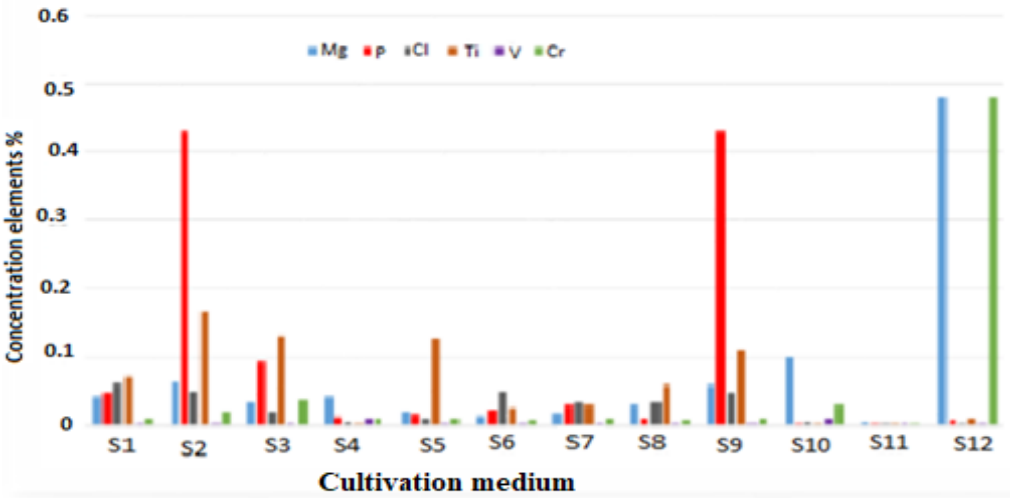

Figure 7-The concentration elements of (Mg, P, Cl, Ti, V, Cr) % using XRF

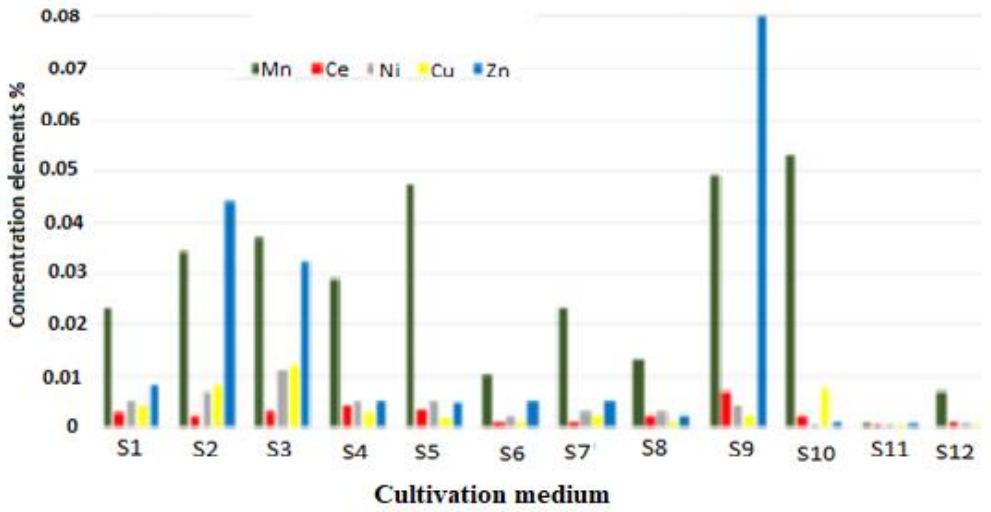

Figure 8-The concentration elements of (Mn, Co, Ni, Cu, Zn)% using XRF

Figures-(9, 10) shown the concentration of trace elements (Ge, As, Se, Br, Sr, Y, Mo, Cd, I, Hg, Pb and U).Cultivation medium used in this work contain different levels of most of the essential elements of the plant.

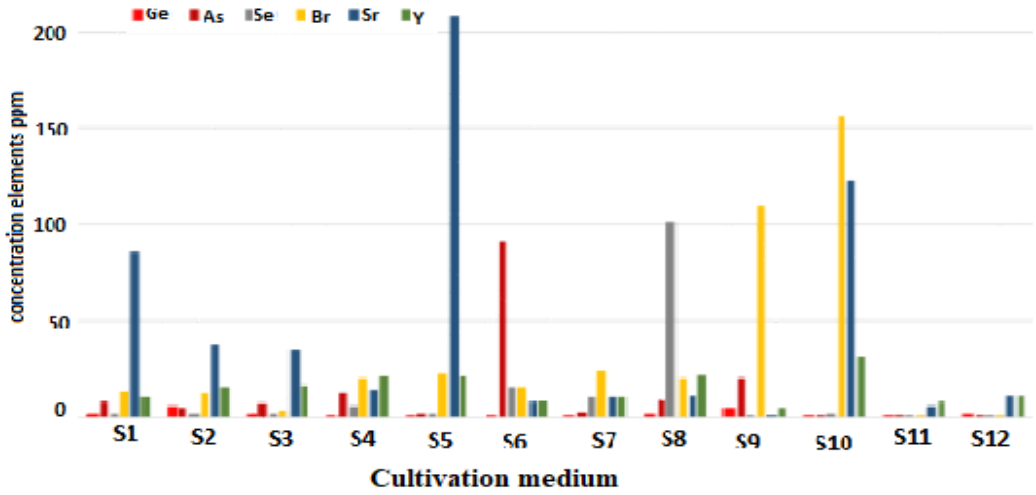

Figure 9-Concentration elements of (Ge, As, Se, Br, Sr, Y) ppm using XRF.

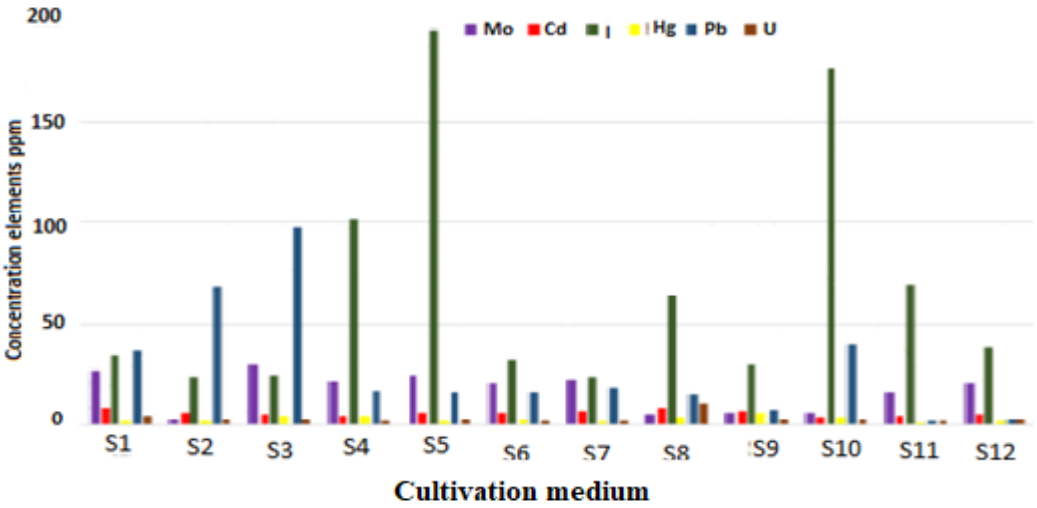

Figure 10-The concentration elements of (Mo, Cd, I, Hg, Pb, U) ppm using XRF.

The elemental composition of twelve cultivation media is determined by Atomic Absorption Spectrometer (AAS) method. The concentrations of elements in Figure-11 were shown that the highest concentrations are that for calcium and potassium in all samples. The concentration for the elements (Cu, Mn, Zn and Pb) are trace.

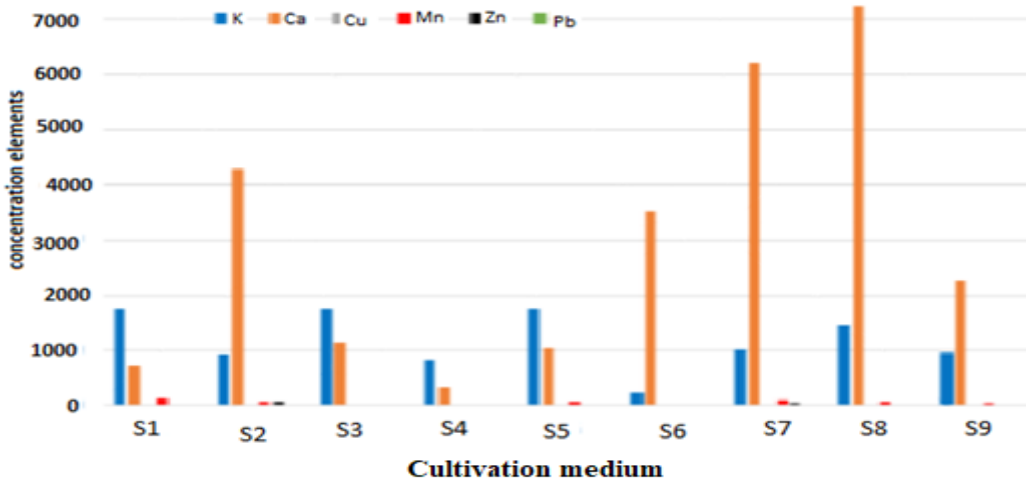

Figure 11-The concentration elements of (K, Ca, Cu, Mn, Zn, Pb) ppm using AAS

4. Conclusion

The cultivation medium analyzed by XRF method has in them different elements like (K, Fe, Ca and Si) which are beneficial to plant health and growth. This is considered safe for use on our croplands. However, some samples such as Al and Cr were found to be of a higher concentration than found in agricultural soils.

The results were compared to some elements using the atomic absorption technique. The difference in results between the two technologies resulting from the error measurement.

The atomic absorption spectroscopy identifies the concentration of elements and the error of concentrations trace elements is very small in this technique.

Acknowledgments

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References

1. Benton, J. J. **2005**. *Hydroponics* (*A Practical Guide for the soilless Grower*), second ed., New York. p: 3-4.
2. Njinga, R.L., Baba, A., Okoh, S. and Muhammad, T.A. **2011.** Evaluation of trace elements in clay sediments products of tatiko locality using x-ray fluorescence technique. *Journal Advances in Applied Science Research*, **2**(6): 370-378.
3. Pooja, Ch., Chauhan, R.P. and Monika, G. **2013.** Estimation of naturally occurring radio nuclides in fertilizers using gamma spectrometry and elemental analysis by XRF and XRD technique , *J. Micro chemical Journal*, **106**: 73-78.
4. Murray, B., Bride, M.C., Greame, S. **2001.** Trace Element Content of Selected Fertilizers and Dairy Manures as Determined by ICP–MS., *Journal Communications in Soil Science and Plant Analysis*, **32**: 139-156
5. Rauof, Ab. L. M., Hammud,K.K., Ahmed,Ab.N.,Thabit, M. K. **2014.** Elemental analysis of commercial fertilizers in Iraqi market, *Journal Archives of Applied Science Research*, **6**(5): 90-95.
6. Benson, N.U., Anake, W. U. and Etesin, U.M. **2014.** Trace Metals Levels in Inorganic Fertilizers Commercially Available in Nigeria, *Journal of Scientific Research & Reports*, **3**(4): 610-620.
7. Elisha, J. J. and Elisha, M. J. **2012.** Characterization of Selected Inorganic Fertilizers by Atomic Absorption Spectroscopy: Possible Carryover of Heavy Metals from Phosphate Rock, *International Journal of Science and Research*, **3**: 94-96.

8. Shunchun, Y., Jidong, L.U., JunyanA. L., Kai Chen, J.L. and Donga, M. **2010.** Multi-elemental analysis of fertilizer using laser-induced breakdown spectroscopy coupled with partial least squares regression. *J. Anal. At. Spectrom*., **25**(11): 1733-1738.
9. RauofAbd L.M., Hammud, K.K., Znad, D.E., Abdul Rahman, F.N., Khalaf, H. and Abd, R. **2015.** Flame Atomic Absorption (FAAS) and X-Ray Fluorescence (XRF) spectroscopic Elemental Analysis of Commercial Fertilizers in Iraqi Market, *International Journal of Advances In pharmacy, Biology and Chemistry*, **4**(4), Oct-Dec.: 794-780.
10. Martinez, L., Avila-Perez, T.P., Zarazua, G. and Tejeda, S. **2007.** EDXRF analysis of some samples of cigarette paper, *Journal of Radio analytical and Nuclear Chemistry*, **273**(3): 759-762.
11. Brouwer, P. **2003.** Theory of XRF Getting acquainted with the principles. 1st Ed, PANalytical B.V. Almelo, Netherlands.
12. Misra, N.L. **2011.** Total Reflection X-Ray Fluorescence and Energy-Dispersive X-Ray Fluorescence characterizations of nuclear materials, *PRAMANA Journal of physics*, **76**(2): 201-212.
13. Rajurkar, N.S. and Damame, M.M. **1997.** Elemental Analysis of some herbal plants used in the treatment of cardiovascular diseases by NAA and AAS, *J. Radio-analytical Nuclear Chem.*, **219** (1): 77-80.
14. Khuder, A., Sawan,M.K.H., Karjou, j. and Razouk, A.K**. 2009.** Determination of trace elements in Syrian medicinal plants and their infusions by energy dispersive X-ray fluorescence and total reflection X-ray fluorescence spectrometry, *J. Spectro. Chimica. Acta.*, **B**(64): 721-725.
15. Elisha, J.J. **2014.** Elemental Composition of Selected Inorganic Fertilizers in Zaria by XRF Method: A Source of Possible Environmental Contamination, *Journal of Applied Chemistry*, **7**(4): 01-03.