ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 11, Issue, 04, pp.2995-2998, April, 2019

DOI: https://doi.org/10.24941/ijcr.35051.04.2019

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

ASSESSING THE EFFECTIVENESS OF *CORIANDER SATIVUM, MENTHA PIPERITA* AND *THINOPYRUM INTERMEDIUM* IN REMEDIATION OF WATERS WITH HEAVY METAL TOXICITY

[1]Neena K. Dhiman, [2]Anjali Deswal, [2]Dharvi Mahajan, [3]Shashi Tyagi and [1, *]Rashmi Saini

[1]Department of Zoology, Gargi College, University of Delhi, Delhi-110049, India
[2]Department of Life Sciences, Gargi College, University of Delhi, Delhi-110049, India
[3]Department of Botany, Gargi College, University of Delhi, Delhi-110049, India

ARTICLE INFO

Article History:
Received 14th January, 2019
Received in revised form
20th February, 2019
Accepted 17th March, 2019
Published online 30th April, 2019

Key Words:
Heavy metals,
Wheatgrass,
Coriander,
Peppermint,
Biosorption,
Toxicity.

***Corresponding author:** Rashmi Saini

ABSTRACT

An unfortunate consequence of industrialization and urbanization is the generation and release of toxic waste products in every resource. However, contamination of water with heavy metals poses a potential health hazard. Biosorption is a promising method for removing metal contaminants from waters in a low cost and environment friendly manner. Due to their high metal binding capacity, present study was carried to investigate the Chromium (Cr), Manganese (Mn), Cobalt (Co), Nickle (Ni), Copper (Cu), Zinc (Zn), Cadmium (Cd) and Lead (Pb) contents in waters treated with biomass of coriander (*Coriander sativum*), peppermint (*Mentha piperita*) and wheatgrass (*Thinopyrum intermedium*). The contents were determined by ICP-MS (Mass Spectroscopy). Percentage absorption of heavy metals by coriander followed the trend Mn (69%) >Co (43%)> Cr (33%)> Zn (18.7%)>Cd (16%)> Ni (10.6%)> Cu (1.6%), for peppermint Mn (20%)> Ni (15.9%)> Pb (13%)> Cu (9.7%)> Co(9.3%)>Cr (6%)> Cd (4.8%)> Zn (1%) and for wheatgrass Mn (99.5%)> Cr (76.4%)> Zn (61.3%)> Co (45.9%)> Cd (41.1%)> Ni (28.7%). Cr (5.8%). The maximum uptake of Cr (76.4%), Mn (99.5 %), Co (45.9 %), Ni (28.7 %), Zn (61.3 %), Cd (41.1 %) was reported in wheatgrass and Cu (9.7 %) in peppermint. Pb (13 %) however was absorbed only by peppermint. The study concluded that there is significant absorption of heavy metals in coriander, peppermint and wheatgrass and an awareness regime needs to be generated to employ these biomasses for phytoremediation of waters with heavy metal toxicity.

***Citation*: *Neena K. Dhiman, Anjali Deswal, Dharvi Mahajan, Shashi Tyagi and Rashmi Saini,* 2019.** "Assessing the effectiveness of *Coriander sativum, Mentha piperita* and *Thinopyrum intermedium* in remediation of waters with heavy metal toxicity", *International Journal of Current Research*, 11, (04), 2995-2998

INTRODUCTION

Heavy metal contamination in waters is a worldwide common environmental hazard because of bioaccumulation of heavy metals at each successive trophic level of food chain, thereby ultimately reaching the top of food chain to pose detrimental health risks to mankind. The contaminations may originate from natural and anthropogenic sources. The latter being much more significant and of our concern. Anthropogenic contamination may occur due to mining, industrial activities, traffic, indiscriminate and inadequate use of chemical fertilizers and other xenobiotics in agriculture and amendment with sewage sludge (Gyula *et al.,* 2013). The excessive intake of heavy metals by man leads to mucosal irritation, widespread capillary damage, hepatic and renal necrotic changes, problems of central nervous system followed by depression and gastrointestinal irritation (Kalavathy *et al.,* 2005). Heavy metals known for their highly toxic properties pose an invisible but serious threat to aquatic ecosystems also. Heavy metals have different solubility, but may be accumulated by plants. (Fodor, 2002; Shah and Reddy, 2010). This not only leads to a major threat for heavy metal uptake by vegetables and crop plants (Karamtothu *et al.,* 2015) but also provides a possibility to remove heavy metals from soils by cultivating specific plant species (Adeel and Malik, 2014). Phytoremediation is a plant based cost effective technology to detoxify or stabilize contaminated soils (Mukthi *et al.,* 2016). The biomass has capacity to scavenge high concentrations of toxic metals from contaminated waters due to its high tolerance to stresses, fast growing habit and large biomass. This technique is based on chelate assisted metal mobilization and uptake i.e. phyto - extraction. Fast growing, high biomass, perennial plants may provide a feasible and cost effective solution (Lewandowski, 2006). Heavy metals such as Cadmium (Cd), Copper (Cu), lead (Pb), Mercury (Hg), Nickle (Ni) and Zinc (Zn) are major pollutants which can lead hazards to other life forms also. Elements like Arsenic (As), Lead (Pb), Cadmium (Cd) and Mercury (Hg) are not recommended to enter body even in ultra-trace levels. Three heavy metals of greatest health concern are Cd, Pb and Hg. There is no biological need of any of these but their increased concentrations in environment are of concern because of their carcinogenic properties, non-biodegradability and bio accumulation thereby having great impact on human health (Konopka *et al.,* 1999). The occurrence and accumulation of these in environment is as a result of direct or indirect human activities such as rapid industrialization, urbanization and anthropogenic sources and activities (Akpor and Muchie, 2010). Once present in excess, Mn, Cu, Zn, Co, Mo and Fe become poisonous and their bioaccumulation causes chronic acute ailments and even death. (Chander and Brookes, 1991; Aate *et al.,* 2017). Regular monitoring of heavy metals in food chain has been suggested and it was emphasized that use of wastewater should be discouraged for irrigation (Cao and Hu, 2000). The toxic metals existing in high or even low concentrations must be effectively treated or removed from waste waters (Kumar and Seema, 2016). The significance of developing new removal methods for heavy metals from waste water samples has been widely recognized in the field of environmental sciences (Baysal *et al.,* 2013). In the light of detrimental effects of expensive purification extraction procedures, an alternative methodology should be adopted that has low cost, high efficiency with minimum production of chemical and biological sludge. One such techniques is Biosorption i.e. removal of toxic metals from waste waters based on metal binding capacities of various biological materials (Kratochirl and Volesky, 1998). Biosorption is therefore proved to be very effective in removing metal ions from contaminated solutions in an environment friendly manner. The advantage of biosorption treatment method include low cost, high efficiency of metal removal from dilute solution due to high metal binding capacities of biomasses, minimum sludge produced, no requirement of any additional nutrients, regeneration of biosorbent and even recovery of metal (Kratochvil and Volesky, 1998; Ahluwalia and Goyal, 2007). Coriander peppermint and wheatgrass are found in every kitchen on routine basis and can easily be cultivated in many parts of the world and can readily be made available in large quantities for the development of effective biosorbent materials. Phytoremediation of heavy metals from paper mill effluents soils could also be made possible by using Croton sparsiflorus-icm UV (Singh *et al.,* 2004). The success of agricultural wastes at metal adsorption was attributed to the presence of carboxylic groups and lignocellulosic materials (Wigmore, 1985). Being rich in these compounds, a research work was planned to quantify the heavy metal accumulation in coriander, peppermint and wheatgrass based upon which their efficiency can be assessed towards removing toxic heavy metals in contaminated waters. Biosorption of Chromium (Cr), Manganese (Mn), Cobalt (Co), Nickle (Ni), Copper (Cu), Zinc (Zn), Cadmium (Cd) and Lead (Pb) was evaluated by 0.1 g and 1.0 g each of coriander, peppermint and wheatgrass. All of these are easily available and are used on daily basis and many people have experience in growing them.

MATERIALS AND METHODS

The entire procedure was divided into three stages: Growing of plants and preparation of dried biomass, preparation of contaminated test water samples and the actual experiment.

Growing Biomass: The seeds of wheatgrass were washed in cool, clean water using strainer. The pesticide- free seeds were soaked over-night. Soaking facilitates initiation of seed germination. Two inch thick layer of organic compost was used to line the inside of seed trays. Planting of seeds was done by burying them evenly and lightly sprinkling them with water. Seedling trays were covered with sheets of moistened newspaper till the grass was sprouted. Sprouted grass was harvested after 9 or 10 days of growth. Coriander was also grown from seeds in the similar manner while stem cutting was done to prepare seedlings with roots for peppermint and was harvested after 12-13 days of planting.

Preparation of Biomass: The biomass used in the present study was wheatgrass, coriander and peppermint, grown and harvested in organic soil and irrigated with metal free waters. After harvesting, the samples were washed with distilled water to remove particulate material and salts from the surface. They were then dried in the oven at $60^{O}C$ for 2-4 hours. Powdered and sieved biomass of these were stored in air tight containers for use as biosorbent materials for further studies.

Preparation of Solutions: Analytical grade $ZnSO_4.7H_2O$, $MnSO_4$,$K_2Cr_2O_7$, $CoSO_4.7H_2O$, $NiSO_4.7H_2O$, $CuSO_4.7H_2O$ $Zn(CH_3COO)_2.2H_2O$, $Cd(NO_3)_2.4H_2O$ and lead acetate were dissolved in distilled water in order to obtain a solution containing Chromium (Cr), Manganese (Mn), Cobalt (Co), Nickle (Ni), Copper (Cu), Zinc (Zn), Cadmium (Cd) and Lead (Pb). This solution was used for metal biosorption experiments (Welna *et al.,* 2011) Concentration of standard and experimental solutions were evaluated by ICP MS (Moor *et al.,* 2001). After incubation of biomass with heavy metal water solution for 6 hours at $30^{O}C$ temperature, each of the suspension was filtered through medium sized filter paper (Whatman Paper 125 mm Ø) and finally through 0.22 µm pore size syringe membrane filter. The ICP-MS measurements were performed by the use of automated quadrupole Agilent 7900 ICP-MS. Instrumental conditions were set as follows: Input Voltage was 200-240 V at 30 A and 50/60 Hz. Cooling water flow was at the rate of 5 L min^{-1}, temperature 15-40°C and pressure of 230-400 KPa. Auxiliary gas flow of 10-12 ml min^{-1}, coolant gas flow of 20 L min^{-1} and nebulizer flow of 0.2 ml min^{-1} was maintained. For the calibration, standard solutions of 10, 50, 100, 250, 500, 1000, 1500 and 2000 ppb were prepared. Deionized water was used for the preparation of all solutions. The substances used for preparation of all the solutions were of high analytical purity. All the samples were centrifuged, filtered and transferred into ICP vials and run through ICP MS. For calculations following equation was used:

$$100-(C_e/C_k x\ 100) = X$$

Where, C_e is the calculated mean experimental metal concentration (determined through ICP after biomass treatment), C_k is the known metal concentration without biomass addition (corresponds to the value determined in metal control samples) and X is the percentage of metal removed. Correlation analysis was applied to the experimental data in order to assess relationship between elements and to give better insight into the element uptake process.

RESULTS AND DISCUSSION

In this study, biosorption of Chromium (Cr), Manganese (Mn), Cobalt (Co), Nickle (Ni), Copper (Cu), Zinc (Zn), Cadmium (Cd) and Lead (Pb), by biomass of *Coriander sativum Mentha piperita* and *Thinopyrum intermedium* (Wheatgrass) was used. Binding capacity of biomass of these three herbs to metal ions is attributed to presence of high number of carboxylic acid groups (COOH) and hydroxyl groups (OH), where metal can bind to replace H. It is evident from the results that percentage removal of toxic elements from the solution with 1.0 g of biomass of each plant is significantly higher than the 0.1 g of biomass used for each. Thereby indicating that 1 g as more appropriate dose over 0.1 g for removing same concentration (5 ppm) of toxic elements in solution (Fig. 1-3). The mean values for all the eight toxic elements have been presented in (Fig. 4).

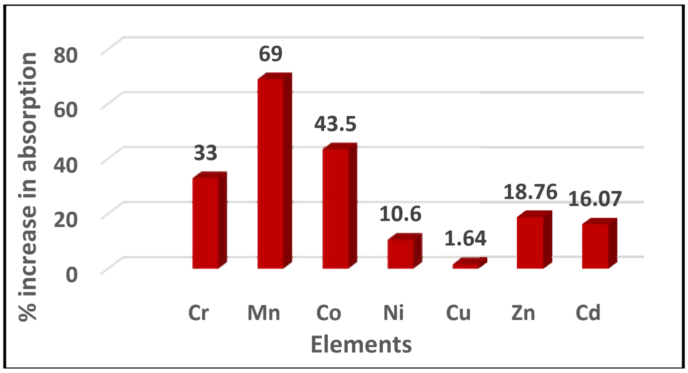

Fig.1 Percentage Increase in absorption of elements by *Coriander sativum*

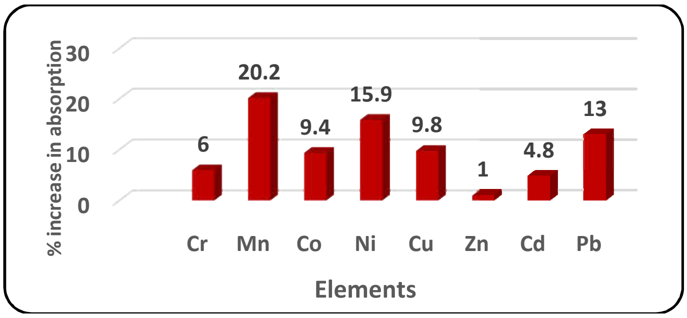

Fig.2 Percentage Increase in absorption of elements by *Mentha piperita*

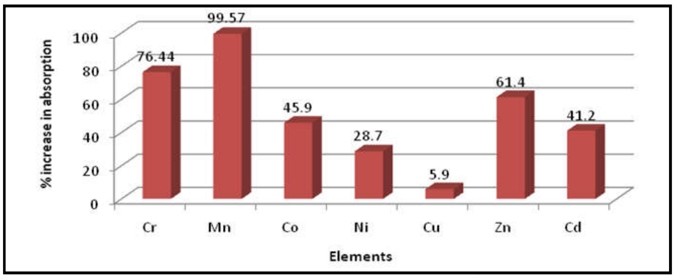

Fig.3 Percentage Increase in absorption of elements by *Thinopyrum intermedium*

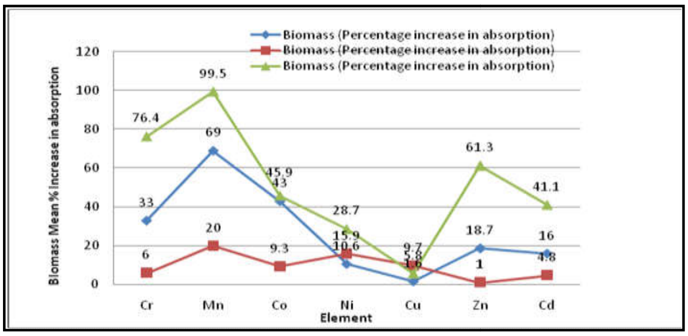

Fig.4 Percentage Increase in absorption by *Coriander sativum*, *Mentha piperita* and *Thinopyrum intermedium*

Results depicted significant increased content of Cr in wheatgrass (76.4%) followed by content in Coriander (33%) and significant lowest content in peppermint (6%). This substantiated the highest efficiency of wheatgrass for Cr absorption followed by coriander and peppermint. For Mn, the highest content was found in wheatgrass (99.5%) followed by coriander (69%) and significantly lowest in peppermint (20%) confirming the highest efficiency of wheatgrass for Mn absorption followed by coriander and peppermint. For absorption of Co, wheatgrass (45.9 %) was found to be most efficient as compared to coriander (43%) and peppermint (9.3%). For Ni absorption, wheatgrass was found to be most effective (28.7 %) over peppermint (15.9 %) and coriander (10.6 %). For Cu absorption, peppermint was most effective (9.7 %) as compared to wheatgrass (5.8 %) and coriander (1.6 %). For absorption of Zn, wheatgrass (61.3 %) was most efficient followed by coriander (18.7 %) and peppermint (1.0 %). Absorption of Cd was found maximum with wheatgrass (41.1 %) followed by coriander (16 %) and peppermint (4.8 %). Only peppermint was capable of absorbing Pb (13 %) while coriander and wheatgrass did not contribute to Pb absorption. Coriander and wheatgrass therefore can contribute to increased lead concentration of solution with respect to control. This observation conforms to the results of research on tea leaves (Soliman, 2016). Jin *et al.* 2005 also found that lead is retained in tea leaves in high amounts. Chromium and Zinc biosorption was evaluated by a sea weed *Sargassum sp.* under optimized conditions with similar results (Saravanan *et al.,* 2009). Wheatgrass has been reported to uptake and accumulate radioactive elements like Thorium (Th) and Uranium (U), (Shtangeeva *et al.,* 2006), while accumulation of heavy metal was reported in barley also in addition to wheat (Stojic *et al.,* 2014). In a study conducted by Arbind Kumar and Seema (2016), when coriander was irrigated with waste water, the range of accumulation of heavy metals was found to be 0.58-1.47 mg/ Kg for Cadmium (Cd), 1.2-5.0 mg/ Kg for Lead (Pb), 41.2-70.2 mg/ Kg for Zinc (Zn), 3.8-8.8 mg/ Kg for Copper (Cu), 1.35-2.38 mg/ Kg for Chromium (Cr) and 2.4-4.5 mg/ Kg for Nickle (Ni). They also gave human health risk index (HRI) for heavy metals in vegetables irrigated with waste waters in the order of their mean values as Pb (0.726) > Cd (0.327) > Ni (0.1083) > Cu (0.094504) > Zn (0.0652) > Cr (0.00798). Similar results were reported by Khan *et al.* (2010), Jan *et al.* (2010). Torabian and Mahjouri (2002) reported that accumulation of Cd in plants irrigated with waste water was highest for mint followed by coriander.

Conclusion and Key points

- Coriander, peppermint and wheatgrass biomass when added in same quantity, have different heavy metal uptake due to different resistance and affinity of these plants to different heavy metals.
- The potential of uptake of Cr, Mn, Co, Ni, Zn and Cd was found maximum in wheatgrass, for Cu it was maximum in peppermint which was the only biomass found to absorb Pb.
- The remediation methodology is safe, economically viable and effective.
- The applicationof this technique may offer enormous environmental, public health and cost benefits.

Acknowledgements: The authors acknowledge the facilities available in the college under grant of DBT (Department of Biotechnology) Star College Scheme Funds and IIT (Indian Institute of Technology) Delhi for ICP-MS (Inductively

Coupled Plasma- Mass Spectroscopy) facility for analysis of the samples.

REFERENCES

Aate J, Urade P, Potey L and Kosalge S. 2017. A Review: Wheat grass and its Health Benefits. *Int. J. Pharm. and pharm. Res.,* 9(4): 288-298.

Adeel M and Malik R N. 2014. Human health risk assessment of heavy metals via consumption of contaminated vegetables collected from different irrigation sources in Lahore, Pakistan. *Arabian J. Chem.,* 7(1): 91-99.

Ahluwalia S S and Goyal D. 2007. Microbial and plant derived biomass for removal of heavy metals from waste water. *Biores. Tech.,* 98 (12):2243-2257.

Akpor O B and M Muchie, 2010. Remediation of heavy metals in drinking water and wastewater treatment systems: Processes and applications. *Int. J. Phys. Sci.,* 5 (12), 1807-1817.

Baysal A, Ozbek N, and Akman S. 2013. Determination of Trace Metals in Waste Water and their removal processes. In: Waste Water–Treatment Technologies and Recent Analytical Developments. Intech open Science publishers. Ch-7.

Cao Z H and Hu Z Y. 2000. Copper contamination in paddy soils irrigated with waste water. *Chemosphere*, 41(1-2): 3-6.

Chander K and Brookes P C. 1991. Effect of heavy metals from past application on microbial biomass and organic matter accumulation in a study loam UK. *Soil Biol. Biochem.,* 23: 927- 932.

Fodor F. 2002. Physiological responses of vascular plants to heavy metals, M N V Prasad and K Strzalka (Eds.), Physiology and Biochemistry of Metal Toxicity and Tolerance in Plants Kluwer Academic Publishers, Dordrecht In the Netherlands., pp. 149-177.

Gyula S, Selti A, Czech V, Vashegyi I, Toth b, Cseh E and Fodor F. 2013. Heavy metal accumulation and tolerance of energy grass (*Elymuselongatus subsp. ponticus cv. Czarvasi-1*) grown in hydroponic culture. *Plant Physiol. Biochem.,* 68: 96-103.

Jan F A, Ishaq M, Khan S, Ihsanullah I, Ahmad I, Ahmed I and Shakirullah M. 2010. A comparative study of human health risks via consumption of food crops grown on wastewater irrigated soil (Peshawar) and relatively clean water irrigated soil (lower Dir). *J. Hazard Mater,* 179 (1-3): 612-621.

Jin C W, Zheng S J, He Y F, Zhou G D and Zhou Z X. 2005. Lead contamination in tea garden soils and factors affecting its bioavailability. *Chemosphere*, 59(8):1151-1159.

Kalavathy M H, Karthikeyan T, Rajagopal S and Miranda L R. 2005. Kinetics and isotherm studies of Cu(II) adsorption onto $H_3PO_4^-$ activated rubber wood saw dust. *J. Colloid Interface Sci*., 292: 354-362.

Karamtothu, G N, Devi M A and Naik, S J K. 2015. Heavy Metals in Soils and Vegetables Irrigated with Urban Sewage water - A Case Study of Grater Hyderabad. *Int. J. Curr. Microbiol. Appl. Sci.*, 4 (5), 1054-1060.

Khan S, Rehman S, Khan A Z, Khan M A and Shah T. 2010. Soil and vegetables enrichment with heavy metals from geological sources in Gilgit, Northern Pakistan. *Ecotoxicol. Environ. Safety,* 73 (7): 1820-1827.

Konopka A, Zakharova T, Bischoff M, Oliver L, Nakatsu C and Turco R F. 1999. Microbial biomass and activity in lead-contaminated soil. *Appl Environ Microbiol,,* 65:2256-2259.

Kratochvil D and Volesky B. 1998. Advances in the biosorption of heavy metals. *Trends Biotech.,* 16 (7): 291-300.

Kumar, A. and Seema, 2016. Accumulation of heavy metals in soil and green leafy vegetables, Irrigated with wastewater. *IQSR J. Env. Sci. Toxic Food Tech. [IQSR-JESTFT]*, 10 (10): 8-9.

Lewandowski I, Schmidt U, Londo M, Faaij A. 2006. The economic value of the phytoremediation function – Assessed by the example of cadmium remediation by willow (Salix ssp). *Agricultural Systems,* 89:68–89.

Moor, C., Theopisti, L. and Dietrich, V.J. 2001. Determination of Heavy Metals in Soils, Sediments and Geological Materials by ICP-AES and ICP-MS. *Microchim. Acta,* 136(3-4): 123–128.

Mukthi T., Sreerangam S and Nambaaru S. 2016. A Mini Review on Wheatgrass. *J. Pharm. Phytochem.,* 4 (3): 13-19.

Saravanan, A., Brindha, V., Manimekalai, R., and Krishnan, S. 2009. An evaluation of chromium and zinc biosorption by a sea weed (*Sargassum sp.*) under optimized conditions. *Indian J. Sci. Tech.,* 2(1): 53-56.

Shah, K. and Reddy, M.N. 2010. Accumulation of heavy metals by some aquatic macrophytes In: Engineering and Technology, 3(4): 11125-11134.

Shtangeeva I, Lin X, Tuerler A, Rudneva E, Surin V and Henkelmann R. 2006. Thorium and Uranium uptake and accumulation by wheat-grass and plantain. For. Snow Landsc. Res., 80(2): 181-190.

Singh K P, Mohan D, Sinha S and Dalwani, R. 2004. Phytoremediation of heavy metals from paper mill effluent soil using Croton sparsiflorus-icm UV. *Chemosphere,* 55 (2): 227-255.

Soliman N F. 2016. Metals contents in Black Tea and Evaluation of Potential Human Health Risks to Consumers. *Health Econ. Outcome Res.,* 2(1): 109.

Stojić S M, Ignjatović, L M, PopovS, Škrivanj S, Đorđević A R and Stojić A.2016. Heavy metal accumulation in wheat and barley: The effects of soil presence and liquid manure amendment. *Plant Biosystems,* 150 (1): 104-110.

Torabian A and Mahjouri M. 2002. Heavy metals uptake by vegetable crops irrigated with waste water in South Tehran. *J. Env. Study*. 16 (2)

Welna M, Madeja A S and Pohl P. 2011. Quality of the Trace Element Analysis: Sample Preparation Steps, Wide Spectra of Quality Control, Dr. Isin Akyar (Ed.), ISBN: 978-953-307-683-6, In Tech, Available from: http://www. intechopen.com/books/wide-spectra-of-quality-control/ quality-of-the-trace-element-analysis-sample-preparation-steps.

Wigmore A. 1985. The Wheatgrass Book. Avery Publishing Group Inc. Wayne, New Jersey. 123 Pp. (ISBN:0-89529-234-3)

****