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Heavy Metal Analysis of Locally Available Anticancer Medicinal Plants

Khushnoodur Rehman[1], Muhammad Hamayun[2]*, Sumera Afzal Khan[3], Amjad Iqbal[4] and Anwar Hussain[2]

[1]Department of Botany, Islamia College Peshawar, Pakistan.
[2]Department of Botany, Abdul Wali Khan University Mardan, Pakistan.
[3]Center of Biotechnology and Microbiology, University of Peshawar, Pakistan.
[4]Department of Agriculture, Abdul Wali Khan University Mardan, Pakistan.

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Plant species are used in different forms either dry or fresh to extractthe active ingredients that can be used for medicinal purposes. These active ingredients may or may not contain non-essential elements. One of the main non-essential elementsincludes heavy metals. The consumption of medicinal plants having larger amounts of heavy metals can affect the health of human beings. Currently, we have also assessed eight locally available medicinal plantspecies for endogenous heavy metals (i.e. cadmium, arsenic, mercury, lead and zinc). The results revealed that *Saxifragaf lagellaris, Moringaoleifera,* and *Fegoniacretica* had no lead, where as *Meliaazedarach* had the highest concentration of lead. Similarly, *Saxifragaf lagellaris* had lower concentration of arsenic, while *Albizialebbeck* had zero and *Meliaazedarach* had the highest accumulation of arsenic. Cadmium was absent in *Saxifragaf lagellaris, Withaniacoagulans,* and *Valerianajatamansi*. *Moringaoleifera* had lower and *Meliaazedarach* had the greatest amounts of cadmium. Mercury concentration has been high in *Meliaazedarach* (2.39±0.18 μg/g), followed by *Hedera helix* (0.26±0.02 μg/g), Saxifraga*f lagellaris* (0.051±0.031μg/g) and *Albizialebbeck*(0.041±0.01μg/g). The species, *Fegoniacretica, Valerianajatamansi,Withaniacoagulans, Moringaoleifera* had no mercury. The highest zinc concentration was observed in *Meliaazedarach* and the lowest concentration was found in *Saxifragaf lagellaris.*

Keywords: Medicinal plantspecies, heavy metals analysis, atomic absorption spectroscopy.

Those elements with relative densities of which are higher than water are known as heavy metals (Fergusson, 1990). The elements having atomic weight equal to five or more water molecules are heavy metals (Tchounwou *et al.*, 2012). The elements, which are present in trace amount in nature, are known as heavy metals, they occur in 10 ppm (Kabata-Pendias, 2010). There are biological factors which effects the bioavailability of heavy metals, include physiological adaptations and species characteristics and trophic interactions (Verkleji, 1993). On one hand heavy metals negatively affect cell organelles and on another effect processes of cell repair and detoxification (Wang and Shi, 2001). The effects of heavy metals as carcinogen need more elucidation (Tchounwou *et al.*, 2012). Some heavy metals, includingzinc (Zn), and copper (Cu) are needed by

*Corresponding author E-mail: hamayun@awkum.edu.pk

cell enzymes, but many of them are carcinogens and cause cancer and other ailments (Fergusson, 1990; Hambidge and Krebs, 2007). Plant generates reactive oxygen species (ROS) when they are exposed to heavy metals (Shahid *et al*., 2014). Plants have evolved detoxification mechanism which reduce the effects of heavy metals (Yadav, 2010). Plants phytochemicals if consumed can assist in the detoxification process related to antioxidants (Lobo *et al*., 2010). Life is impossible without some metallic ions as these are important parts of enzymes which carry reactions for life. In literature terms, like "trace metals", "micro elements", "trace inorganics" and heavy metals are used as synonyms. The heavy metals are added to the environment from agricultural sources, atmospheric sources,domestic effluent, industrial sources and natural sources (Nagajyoti *et al*., 2010). The concentration of heavy metals in environment is from natural origin as well as anthropogenic activities.Therefore, the presence of heavy metals in the environment of certain countries is high or low depending upon the activities. For example, Cd and Zn concentrations are high in China (Herawati *et al*., 2000), Pb, Ni, Zn are found in higher concentration in Greece (Christophoridis *et al*., 2009). The monitoring of twenty one sites for two years from tributary of Rawal lake Pakistan showedhigher accumulation of Ni, Mn and Pbduring post monsoon seasons. However, during the pre-monsoon season, the concentration of Zn was high and the concentration of Li was low (Zahra *et al*., 2014). The levels of heavy metals are low in residential area than high traffic area. Similarly, lower concentrations of heavy metals has been observed in the areas occupied by the dense population of plants have low concentrations of heavy metals (Chibuike and Obiora, 2014). Moreover, some plants have the higher capacity to take more heavy metals as compared to theother species(Chibuike and Obiora, 2014). The accumulation of heavy metal in same species also dependson the environmental conditions of the area. Our work was focused onexploring new potent plant specieswith low heavy metal contaminations, yet effective against cancer.

MATERIALS AND METHODS

Medicinal plants were collected in the remote area of Peshawar. The samples were washed to remove dirt, air dried and ground to powder by a grinding machine. Wet digestion method was adopted for the preparation of samples for heavy metals analysis by atomic absorption spectrophotometer (Meena *et al*., 2010). Approximately, 0.5 g to 1.0 g of the each plants sample was weighed and digested with 15 ml of 20 % sulphuric acid solution intest tube. The test tube containing sample was left for 24 h, so that the sample can be fully dissolved in the solution. For efficient digestion, each test tube was heated for 10 to 15 minute.The solution of each test tube was then filtered through Whatman filter paper. Distilled water was finally added to each filtrate to make the final volume of 30 ml. Flame atomic absorption spectrophoto meter was used to measure

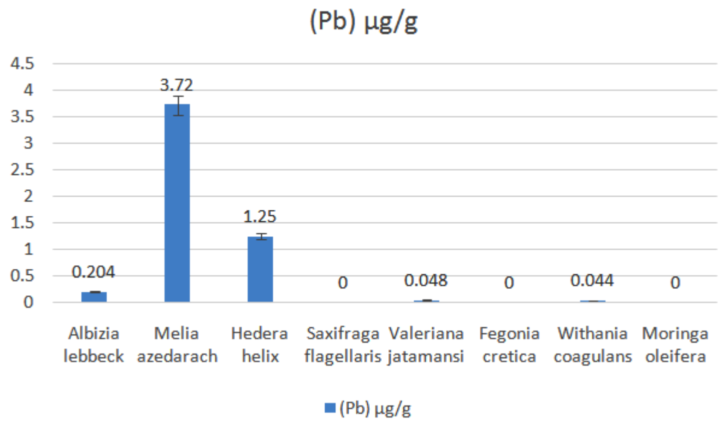

Fig. 1. Lead concentration in selected medicinal plants, using wet digestion method

the concentration of lead, mercury, arsenic, cadmium and zinc in each extract of plant sample.

RESULTS

Lead concentration

The Lead concentration was different in selected species but almost all were in nontoxic level. In *Saxifraga flagellaris, Moringaoleifera,* and *Fegoniacretica*, nolead was detected, while *Withaniacoagulans* and *Valerianajatamansi* hadl owest concentrations of lead, i.e. 0.044±0.026µg/g and 0.048±0.022µg/g, respectively.*Albizialebbeck* (0.204±0.11µg/g) and *Hedera helix* (1.25±0.07µg/g) had moderate concentrations of lead and the highest concentration was found in *Meliaazedarach* 3.72±0.25 µg/g (Fig. 1).

Arsenic concentration

Arsenic concentration in *Saxifragaflagellaris* was 0.195±0.135 µg/g. The medicinal plant species, *Moringaoleifera* had 0.208±0.151 µg/g, *Fegoniacretica* had 0.375±0.171 µg/g, *Withaniacoagulans* had 0.542±0.17 µg/g, *Valerianajatamansi* 0.552±0.14 µg/g and *Hedera helix* 1.30±0.06µg/g arsenic. Moreover, *Albizialebbeck* had no detectable arsenic, whereas highest accumulation of arsenic was found in *Meliaazedarach*, i.e.3.74±0.24 µg/g (Fig. 2).

Cadmium concentration

The availability of cadmium was nil in *Saxifragaflagellaris, Withaniacoagulans* and*Valeriana* jatamansi. The concentration of cadmiumin *Moringaoleifera* was 0.060±0.021µg/g, *Fegoniacretica* was 0.041±0.001 µg/g, *Albizialebbeck* was 0.021±0.002 µg/g and *Hedera helix* was 0.41±0.02 µg/g. Among the tested medicinal plants, *Meliaazedarach* (1.84±0.13µg/g) had the highest amounts of heavy metal cadmium (Fig.3).

Mercury concentration

The highest mercury concentration was confirmed in *Meliaazedarach* (2.39±0.18µg/g), followed by *Hedera helix* (0.26±0.02µg/g), Saxifraga*flagellaris* (0.051±0.031µg/g) and *Albizialebbeck* (0.041±0.01µg/g). The tested medicinal plants, *Fegoniacretica, Valerianajatamansi, Withaniacoagulans* and *Moringaoleifera* were found to have no mercury (Fig. 4).

Zinc concentration

The medicinal plant, *Meliaazedarach* (1.76±0.15µg/g) had the highest concentration of zinc, followed by *Hedera helix* (0.49±0.08µg/g), *Fegoniacretica* (0.395±0.15µg/g), *Moringaoleifera* (0.360±0.18µg/g), *Withaniacoagulans* (0.287±0.16µg/g), *Valerianajatamansi* (0.203±0.15µg/g) *and Albizialebbeck* (0.13±0.002µg/g).The least concentration of zinc was found in *Saxifragaflagellaris* (0.108±0.007µg/g) (Fig. 5).

DISCUSSION

The medicines, which are acquired from plants, are considered less toxic than Allopathic drugs, But if these plants contain heavy metals then in spite of it that these shows biological

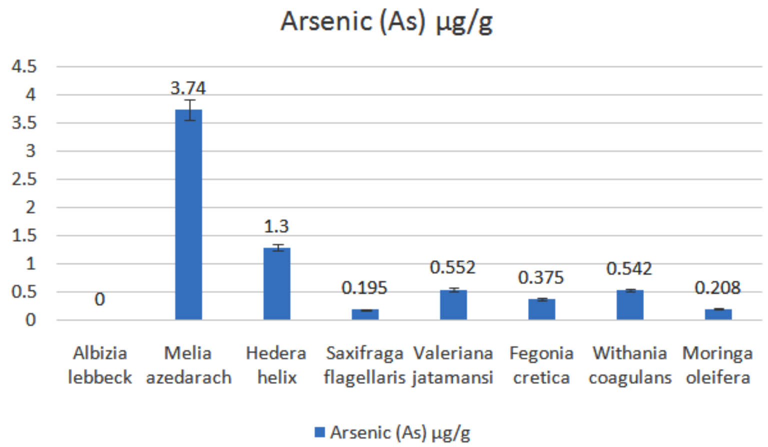

Fig. 2. Arsenic concentration in selected medicinal plants, using wet digestion method

activities are rather unfit to be used as medicines. Metal noxiousness has extraordinary influence and significance concerning plants and ultimately the entire ecosystem is affected with it. Apart from the accumulation, these toxic heavy metals retard growth, lower productivity of ecosystem and alter metabolism of the whole ecosystem in large. Which effect the physiological and biochemical characters

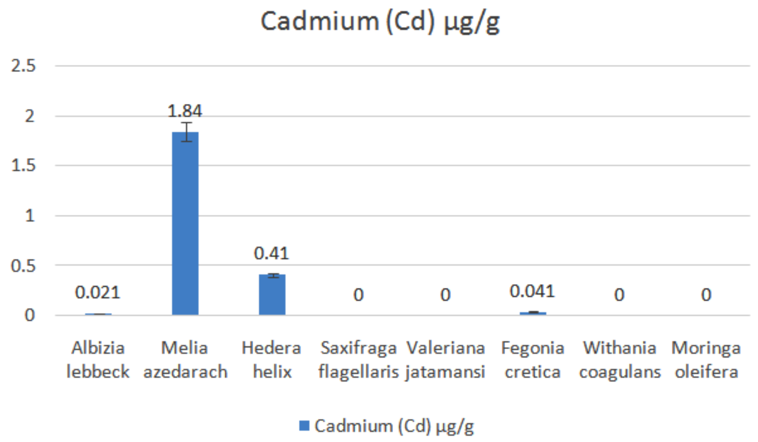

Fig. 3. Cadmium concentration in selected medicinal plants, using wet digestion method

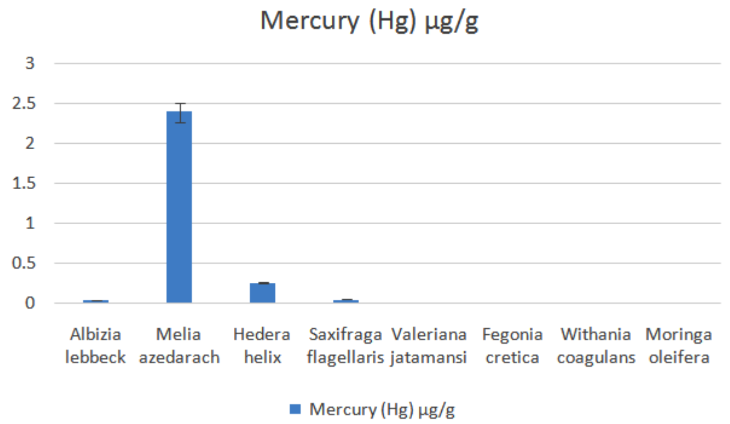

Fig. 4. Mercury concentration in selected medicinal plants, using wet digestion method

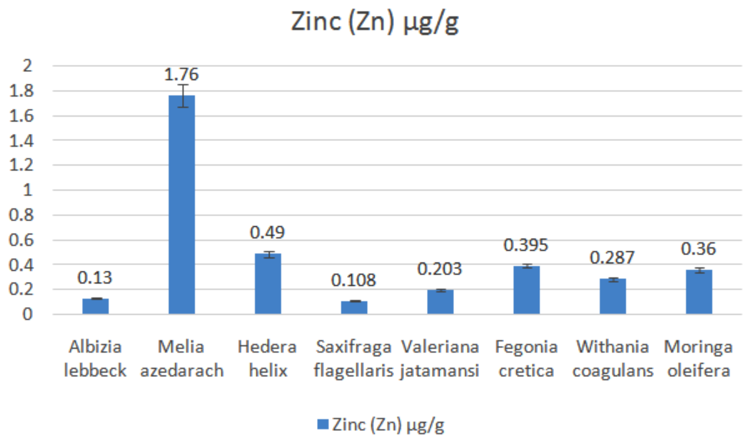

Fig. 5. Zinc concentration in selected medicinal plants, using wet digestion method

of these plants and the consumers of ecosystem as well (Nagajyoti *et al*., 2010). There are plants, which are "hyper accumulator" regarding their ability to adopt to metalliferous soils. There are three factors, which differentiate the "hyper accumulator" form other non- hyper accumulators plants one factor is that these plants have elevated tendency for heavy metal uptake, second that have faster translocation and third these plants have the ability to detoxify heavy metals (Rascio and Navari-Izzo, 2011). The damage by heavy metal to human beings in special and other living being in general is increasing day by day. Among the ninety two (92) elements thirty (30) elements are toxic to human health, which are Al, As, B, Be, Co, Cr, Cu, Li, Mn, Ni, Se, Ti, V, Sb, Te, Cs, Au, Hg, Pb, Sr, Mo, Pd, Bi, Ba, W, Pt, Sn, Ag and Cd. The metallic elements which contain higher atomic weight than 40.04 (the atomic mass of Ca) are known as heavy metals(Morais *et al*., 2012; Yu and Tsunoda, 2004; Otte, 2006). Among the metals arsenic (As), Lead (Pb), mercury (Hg), and cadmium (Cd), are present in every environment. These elements have no benefit to human health (Vieira *et al*., 2011). Even at low concentrations, they have very adverse effects on the human health and cause cancer (Carlin *et al*., 2015). Lead is brought to surface of earth by humans and is more toxic. In oceans the concentration of lead is 0.01-0.02 ìg/L, but near surface the ocean water contain as much as ca. 0.3 ìg/L (Castro-González and Méndez-Armenta, 2008). Plants with lead accumulated may triggers food chain with toxic effects. These toxic effects are ultimately faced by human being as man is the part of ecosystem. Humans when inhale lead, 50% of that becomes the part of the body. Especially bones and teeth contain more than 90% of lead (Yu and Tsunoda, 2004). The effect of lead on children growth is very severe and it has very bad effect on their mental health (Castro-González and Méndez-Armenta, 2008).

Children are particularly sensitive to this metal because of their more rapid growth rate and metabolism, with critical effects in the developing nervous system (ATSDR, 2007; Castro-González & Méndez-Armenta, 2008). The Joint FAO/ World Health Organization Expert Committee on Food Additives (JECFA) established a provisional tolerable weekly intake (PTWI) for lead as 0.025 mg/kg body weight (bw)(JECFA, 2004). The WHO provisional guideline of 0.01 mg/L has been adopted as the standard for drinking water(WHO, 2004).

Cadmium use is not very old to humans. The advancement in technology increased the use of Cadmium. It is now seriously considered as pollutant. It is present naturally in water, Air and soil naturally as well. The era of industrialization led to increase its concentration in environment than ever before (Fytianos *et al*., 2001). Tobacco contain highest amount of cadmium and its absorption via lungs is greater than gastrointestinal tract. It is present in the form of inorganic salts, and the organic compounds, which contain Cadmium, are very unsteady. Plants easily absorb it in the form of ions, and these ions are present all parts like roots, seeds and leaves of the plants. Some researcher found that the Kernel of wheat and Rice contain more cadmium than other parts (Figueroa *et al*., 2008). The safe mentioned slandered by FAO/ WHO has the PTWI as 0.007 mg/kg for cadmium (JECFA, 2004). The EPA maximum pollutant level for cadmium in drinking water is 0.005 mg/L while the WHO accepted the conditional recommendation of 0.003 mg/L(WHO, 2004). The most toxic heavy metal in environment is Mercury. It is added into environment by man from farming industry (fungicides, seed stabilizers), by drugs industry, paper industry, and batteries (Zhang and Wong, 2007). Exposure to it can damage central nervous system and other health hazards are brought by it to humans. Majority of food contain up to 50 ìg/kg (Jaishankar *et al*., 2014). The revised JECFA PTWI scale for toxic level of mercury is 3.3 mg/kg b.w./ week PTWI of 1.6 mg/kg body weight(JECFA, 2004). As the element is extreme toxic to human health the current standard for drinkable fresh water by EPA and WHO are 0.002 mg/L and 0.001 mg/L, correspondingly(JECFA, 2004). Arsenic is rarely found in usual environment, but present as arsenides in the ore of sulphur.it is more abundant in aquatic environment in oxidation states than land, but may be abundant in those areas where arsenical insecticides are frequently used Inorganic arsenic is cancer-causing and specially cause cancer in lungs and skin (Smith *et al*., 2003). The JECFA established a PTWI for inorganic arsenic as 0.015 mg/kg body weight and arsenic consumptions is 0.05 mg/kg body weight/

day(JECFA, 2004). Zinc is vital element for fitness and growth specially plants but in excess amount may cause severe health problems and toxicity. If the quantity of it exceeds than 225 µg/g then it is toxic. Though it is important co-factor for many nucleic acid synthesizing enzymes, but still its higher concentration may cause pyrexia, nausea and laziness. The taken amount of zinc should not exceed than 10,000 and 20,000 µg/day (Bhutta *et al*., 1999).

CONCLUSION

Medicinal plants can provide protection against life threatening ailments, like cancer. The South East Asia is blessed with potent plant species that are used as medicine and food supplement. Though, medicinal plants have benefits, but consumption of such plants in higher amounts might be harmful due to the presence of heavy metals. The heavy metals are useful when used in optimum quantities, but get toxic at higher amounts. From the results of our study, we conclude that the presence of heavy metals was in very low quantities and these plant species can be used freely to treat life threatening cancer.

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