



Original Research Article

Heavy metal content analysis of herbal plants gathered in various parts of Faisalabad, Pakistan

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ABSTRACT

In recent decades, herbal therapies derived from plants have become increasingly popular, particularly in disadvantaged countries with limited access to western medical care. Due to their lower adverse effect risk, less cost, and greater accessibility, herbal medications are gaining appeal globally, especially in economically poor developing nations. However, after being collected and processed into herbal remedies, the heavy metals present in medicinal and aromatic plants are absorbed by people, where they then accumulate in various organs. Toxic heavy metals may affect the heart, lungs, liver, and brain, which can be fatal. That is why regulating the amount of potentially harmful heavy metals found in herbal medicine is essential. Six herbs *Adhatoda vasica*, *Bacopa monnieri*, *Ocimum sanctum*, *Emblica officinalis*, *Terminalia arjuna*, and *Glycyrrhiza glabra*, levels of nickel, chromium, mercury, cadmium, lead, and arsenic. As a consequence of our research, we found that the content Ni, Pb, Cr, As, Cd, and Hg in *Adhatoda vasica*, *Bacopa monnieri*, *Ocimum sanctum*, *Emblica officinalis*, *Terminalia arjuna*, and *Glycyrrhiza glabra* is lower than what is allowed by the World Health Organization and the Food and Agriculture Organization.

Keywords: Medicinal Plants; Heavy Metals; Human Impacts

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Introduction

The use of phytomedicine in the healing, diagnosis, and control of illness is widespread. A majority of people throughout the globe have some dependence on herbal medications because of the many advantages they provide. Researchers at the World Health Organization have found that more than half of the world's population relies on traditional (alternative) medicine as their primary method of healthcare delivery. Herbal medications are made from a variety of plant components. Leaves, roots, barks, fruits, and seeds are a few examples. Individuals who use herbal medications feel safer than pharmaceuticals because they come from natural sources [1]. Toxic metal contamination and its health consequences on the environment are still significant problems. Some heavy metals in the body may be helpful in small doses, but when concentrations rise over a certain point, harm is done, resulting in acute or long-term poisoning. Plants can accumulate heavy metals in quantities far higher than those found in the environment [2]. Plant-based medicines are thought to have fewer side effects than allopathic medications; however, the hazardous metals found in these products causes health concerns [3]. Heavy metals, chemical poisons, adulterants, and pesticides may increase herbal plants' toxicity. Herbal plants may be considerably influenced by a wide range of factors, including the location, the geochemical qualities of the soil, and pollutants [4].

Pakistan has a diverse medicinal flora, and people use traditional medicine to treat various diseases. Alternative treatments have been tried in Pakistan. Research expeditions were conducted across the province to chronicle ethno-pharmacological plants used by people to alleviate different diseases, spanning diverse rural and tribally inhabited areas. Plants that are used to cure, inhibit, and handle illnesses have been found in Faisalabad from different areas. This might help researcher's better grasp the role of location in medicinal plant collecting and, eventually, heavy metal toxicity. These plants were chosen because they are prevalent in most rural areas and may be found in most herbal treatments. They are also frequently used by individuals and families [5]. *Bacopa monniera* is an herb used to treat various mental health issues, including depression, epilepsy, mania, and hysteria [6]. The herb *Ocimum sanctum* shows antifertility, anticancer, antidiabetic, antifungal, antimicrobial, and effect; it also shows hepatoprotective, cardio protective, antiemetic, antispasmodic, analgesic, adaptogenic, and diaphoretic properties [7]. The herb *Emblica officinalis*, which has a high memory-enhancing effect and cholesterol-lowering properties, is discussed concerning its use in ocular disorders. The properties

of *Emblica officinalis* are taken into consideration as an antibacterial agent, as well as its ability to neutralize snake venom, among other things. Additionally, *Emblica officinalis* has been researched for its antioxidant and immunological modulatory properties, as well as its analgesic and analgesic properties [8]. *Terminalia arjuna* has been utilized as a cardio tonic in treating heart failure, ischemia, cardiomyopathy, atherosclerosis, myocardial necrosis, anemia, venereal disease, and viral disease. It is used to treat sprains, ulcers, and hepatic disease, and it has been shown to have hypocholesterolemic, antibacterial, antimicrobial, anticancer, antioxidant, ant-allergic, and antifeedant properties [9]. People have used *Glycyrrhiza glabra* for a long time to treat respiratory problems, hyperpiesia, epilepsy, fever, and sexual debility. Another use of the herb was for things like rheumatism and ulcers in the stomach [10].

Experimental

Six herbal plants *Adhatoda vasica*, *Bacopa monnieri*, *Ocimum sanctum*, *Emblica officinalis*, *Terminalia arjuna*, *Glycyrrhiza glabra*. The plant samples were collected in April, December 2021 and January 2022 from rural places in Faisalabad, the sample was identified by the department of botany Faisalabad Agricultural University, Faisalabad.

After washing and air-drying for a week at room temperature in a dust-free environment, samples were crushed using a porcelain mortar and pestle. Six composites were obtained by weighing 1 g of each of the five sub-samples for each medicinal plant type. Before analysis, we put the powder composite material in plastic boxes and put them in a cold, dry area. 1 g of the pre-weighed sample of each medicinal plant was put into a beaker. After that, a succession of an acid mixture consisting of 4 mL of H₂SO₄, 2 mL of HClO₄, and 2 mL of HNO₃ (in the proportions 2:1:1) was added.

Ni, Cr, Cd, As, Hg and Pb a succession of an acid mixture consisting of 4 mL of H₂SO₄, 2 mL of HClO₄, and 2 mL of HNO₃ (in the proportions 2:1:1) was added. The solution was brought to a temperature of 250 degrees Celsius and allowed to remain there until a clear solution could be formed. A membrane filter paper (Whitman filter paper No. 41) was then used to filter the solution. Distilled water was added to the filter to bring it up to the proper level. Before analysis, the digested samples were placed in plastic bottles and kept at 4 °C. High purity standard solutions of the metals were used to produce stock solutions of the metals, from which calibration standards were

obtained. For each of the metals under investigation, 1,000 mg/L working standard solutions were created using pure standards from Merck, Germany. All sample analyses were done in triplicates, and we ran standards and blanks at regular intervals to verify repeatability. The sample was spiked with standards of known quantities for the recovery analysis. Equation 1 was used to calculate the percentage of recovery.

$$\% \text{ recovery} = \frac{\text{concentration of spiked samples} - \text{concentration of un-spiked samples}}{\text{concentration of known spike added}}$$

After that, plant samples were mixed with 4 ml sulphuric acid, 2ml nitric and 2ml perchloric acid (2:2:1) to make an acid digest for each species (10 ml). One millilitre of each sample's acid digest was diluted to 20 ml because of the acid's corrosive nature, so it had to be diluted a lot more than that. Aliquots of the mixture were used to figure out how much nickel, chromium, mercury, cadmium, lead, and arsenic there was in it. They used atomic absorption spectrophotometers to do this (model AA240FS, USA). Heavy metal detection limits and standard atomic absorption conditions are shown in table 1. All of the samples were analysed twice, and the data was reported as a mean of the data from the analysed samples in $\mu\text{g/g}$.

Results and discussion

In the present investigation *Adhatoda vasica* had Ni, Cr, Cd and Pb concentrations is maximum in winter at 0.87, 0.76, 0.69, 0.07 and 0.71 $\mu\text{g/g}$, whereas As, Hg in monsoon it is 0.37 and 0.70 $\mu\text{g/g}$ far lower than the WHO or FAO-permitted levels. Moreover, we found that among Ni, Cr, Cd, As, Hg and Pb, the Pb content in *Bacopa monnieri* is 1.87 $\mu\text{g/mg}$ in winter is far lower than the WHO or FAO-permitted levels. Furthermore, the Cr content among six heavy metals in *Ocimum sanctum* is maximum 1.68 $\mu\text{g/mg}$ in monsoon far lower than the values approved by the WHO or FAO. Additionally, the Cd content is maximum in *Embllica officinalis*, is 1.11 $\mu\text{g/mg}$ lesser than the WHO or FAO-allowable standards. In addition, we found that the Hg content in *Terminalia arjuna* is minimum at 0.001, the Cr content in *Terminalia arjuna* and *Glycyrrhiza glabra* is maximum at 1.78 $\mu\text{g/mg}$ and 1.85 in winter is lower than the WHO or FAO-allowed thresholds. This research

clearly indicated that *Ocimum sanctum*, *Emblica officinalis*, and *Glycyrrhiza glabra* is free of Cd and Hg. As a result of our study we revealed that the values of Ni, Cr, Cd, As, Hg and Pb, the Pb in herbs significantly lower than the WHO or FAO-permitted standards.

The rapid growth of industries and motorization, as well as the widespread use of pesticides and fertilizers, have all contributed to a steadily increasing chemical and heavy metal load in the atmosphere and soil. The plants that thrive in these contaminated environments acquire toxins and heavy metals, making their way into the human food chain through various plant parts, extracts, and preparations. Throughout the globe, people are worried about the impacts heavy metals have on the environment and their health. Medicinal plants are often considered a possible cause of heavy metal poisoning in humans and other animals. Nickel and chromium may also generate harmful consequences in humans; however, mercury, cadmium, lead, and arsenic tend to get the most attention. Lead is the most abundant and stable heavy metal found in the environment. All living things, including animals and bacteria, pose a significant threat. The constant use of fertilizers, burning fossil fuels, and the disposal of sewage sludge are the primary contributors to the alarming rise in lead contamination. It is a non-essential substance that may be taken via the lungs, the stomach, or the skin. This substance is a deadly toxin that builds up in the body over time. Toxicity, including colic, anemia, chronic nephritis, headache, convulsions, brain damage, and central nervous system diseases, may result from exposure to lead levels over the safe threshold or prolonged usage of these contaminated plants [11]. Cadmium is a non-essential trace element linked to several food poisoning incidents in people and plants, but its precise role in either is unknown. There has been a recent uptick in interest since it can be found in just about all environments. Even at low doses, cadmium alters the human kidney's arteries, which may eventually lead to the organ's failure. It builds up in people, biochemically replacing zinc, leading to hypertension, liver damage, and kidney failure. Itai-Itai is an illness caused by cadmium toxicity that leads to brittle bones, anemia, kidney failure, and eventually death [12]. According to researchers mercury can pass the placental barrier and potentially harm the developing fetus. Mercury also induces detrimental effects on the renal and neurological systems. Most people in the general population are exposed to mercury mostly via their intake of fish, which contains methyl mercury, and perhaps through dental amalgam fillings. Infertility, suppression of natural antioxidant enzymes, and brain damage have all been linked to mercury levels over the

government's permitted limits [13, 14]. Alloys in automobiles and chromium production, processing, and recycling contribute to chromium pollution. The metabolism of carbohydrates requires chromium in order to function properly. Additionally, it has a role in the creation of proteins and cholesterol. There is a strong correlation between chromium and insulin, both of which play crucial roles in the pathophysiology of diabetic patients. The pancreas, which secretes insulin, contains chromium. The harmful consequences of chromium consumption include a skin rash, nasal itchiness, bleeding, upset stomach, liver and kidney damage, and perhaps lung cancer. Disturbances in glucose, lipid, and protein metabolism are signs of chromium insufficiency [15]. The most common ailment from Nickel is allergic dermatitis, nickel itch, which usually occurs when the skin is moist. Nickel has been singled out as a substance that may cause cancer and is known to harm the lungs and nasal canals. Even though the body only needs a trace amount of nickel, the pancreas contains most of this element. As a result, nickel is an essential component in insulin generation. Its deficiency may cause serious results in liver disorder [16]. Exposure to nickel may result in many health consequences for humans, including allergies, cardiovascular and renal disorders, lung damage, pulmonary disease, and nasal melanoma [16]. Arsenic is one of the most significant threats to public health since it is a toxic heavy metal. As is often encountered in the workplace or from ingesting polluted water or food. Both its metalloid and therapeutic properties have contributed to lengthy history of usage. It's a pollutant in our environment, water supply, and the food chain. The small intestine is the primary site of As absorption. Skin contact and breathing are two more potential entry points. As a result of its widespread dissemination, the substance causes harm to the body's lungs, heart, kidneys, liver, muscles, and nervous system [17, 18]. In Pakistan, medicinal plants, which form the raw materials for most herbal remedies, should be checked for the presence of heavy metals especially and prescribes limit them. However, most people, living in areas where these plants grow, harvest them locally for their medicinal use without checking for heavy metal accumulation. Most of the Pakistani herbal companies procure raw herbs from commercial suppliers and use them in formulations without checking them for heavy metals.

Tables

Table 1: Heavy metal detection limits and standard atomic absorption conditions

Heavy metal	Wave length	Lamp intensity (mA)	Slit wave length (nm)
Ni	232.0	10	0.2
Cr	357.9	10	0.2
Hg	253.7	04	0.5
Cd	228.8	04	0.7
Pb	283.3	10	0.7
As	193.7	10	0.5

Table 2: Descriptions of medicinal plants, as well as their therapeutic applications ($\mu\text{g}/\text{mg}$) in different seasons W=winter (December), S=summer (April) M=monsoon (July)

Name of plant	Ni	Cr	Hg	Cd	Pb	As
<i>Adhatoda vasica</i> Nees. (Acanthaceae)	W-0.87 S-0.63 M-0.73	W-0.76 S-0.52 M-0.64	W-0.69 S-0.54 M-0.70	W-0.07 S-0.01 M-0.03	W-0.71 S-ND M-0.53	W-0.34 S-0.29 M-0.37
<i>Bacopa monnieri</i> (Scrophulariaceae)	W-0.79 S-0.64 M- 0.57	W-0.56 S-0.65 M-0.74	W-0.07 S-0.03 M-0.01	W-0.37 S-0.14 M-0.10	W-1.87 S-1.04 M-1.35	W-0.019 S-0.023 M-0.034
<i>Ocimum sanctum</i> (Lamiaceae)	W-0.68 S-0.64 M- 0.58	W-1.61 S-1.57 M- 1.68	W-ND S-ND M-ND	W-ND S-ND M-ND	W-0.91 S-0.79 M- 0.90	W-0.16 S-0.11 M-0.08
<i>Emblica officinalis</i> (Euphorbiaceae)	W-1.11 S-1.09 M- 1.06	W-0.81 S-0.78 M-0.79	W-ND S-ND M-ND	W-ND S-ND M-ND	W-0.75 S-0.68 M- 0.71	W-ND S-0.01 M-ND
<i>Terminalia arjuna</i> (Combretaceae)	W-0.58 S-0.45 M-0.52	W-1.78 S-1.51 M-1.67	W-ND S-ND M-0.001	W-ND S-ND M-0.005	W-0.98 S-0.76 M-0.89	W-0.36 S-0.28 M-0.31
<i>Glycyrriza glabra</i> (Fabaceae)	W-0.75 S-0.51 M-0.64	W-1.85 S-1.49 M-1.65	W-ND S-ND M-ND	W-ND S-ND M-ND	W-0.96 S-0.91 M-0.89	W-0.31 S-0.19 M-0.28

Conclusion

All kinds of illnesses, from a basic cold to more serious ones like cancer, may be treated using medicinal herbs. For medical and nutritional purposes, Pakistan's flora is rich in medicinal plants. Everyone has access to raw herbs, but they are not used for a lengthy period of time. Analysis of these therapeutic herbs' heavy metal content revealed that the amounts of the examined heavy metals are much lower than those found in the human body. In light of the long-term toxicity of these heavy metals, it is recommended that additional medicinal herbs be evaluated since the quantities of heavy metals might fluctuate across plant species. As a result, it is advised that before medicinal plants be utilized locally or in a pharmacy, the levels of heavy metals in them be assessed.

Conflict of Interest:

The authors declare that they have no conflict of interest

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