STUDY OF HEAVY METALS (Cd, Cu, Ni, Pb, & Zn) IN SOME MEDICINAL PLANTS OF TURMIC VALLEY GILLGAT BALTISTAN , PAKITAN

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ABSTRACT: *The purpose of this study was to determine whether or not commercially available Pishin herbs pose any significant risk of heavy metal poisoning. The primary goal of this work is to highlight the accumulation of heavy metals (Cadmium Cd, Copper Cu, Nickel Ni, Lead Pb, and Zinc Zn) in medicinal plants (Hertia intermedia, Cardaria chalepense, Scorzonera ammophila, Tamarix karelini, and Astragalus auganus) gathered in the Pishin region of Balochistan province. Heavy metal use and its possible effects on the health of Pishin's local population are investigated. The abundance of heavy metals in the medicinal flora samples further demonstrated that these plants are excellent accumulators and have the potential to act as a detoxifying agent. Additionally, these revered plants are also employed for medicinal purposes.*

Key words: Heavy Metals, Medicinal Plants and Atomic Absorption spectrophotometry

INTRODUCTION

Herbal therapy is the oldest and most widespread kind of treatment in human history, having been used by every human culture from its inception[1]. Since ancient times, humans have depended on the wide range of plant assets for everything from food and clothing to shelter and medicine, all of which may be traced back to the first peoples' steadfast faith in nature as the source of health and vitality. In order to cure illness, people used substances that were not normally a part of their diet, such as some plants, animal parts, and minerals. The first humans experimented to learn to distinguish between beneficial and hazardous plants. As it turns out, even in ancient cultures, people collected information about plants and cultivated widely recognised herbal medicines with remarkable efficiency. An ancient Neanderthal burial site discovered in a cave in northern Iraq in 1960 [2] provides strong evidence of the use of home made medicines precisely 60,000 years ago.

There are still cultures where natural medicine plays a significant role in the treatment process. While there are medicinal plants growing in every region, the tropics are where you'll find the most diversity. It is estimated that 25% of all modern pharmaceuticals are derived, either directly or indirectly, from plants [3-7]. This is only one way that natural medicine has prompted the discovery of novel therapeutic interventions and antidepressant compounds.

Plants have long been relied upon as vital components in traditional medicine for both human and animal health. According to historical records of traditional use of medical plants. Indigenous peoples all across the world have accumulated a wealth of data on the effectiveness of traditional medicines dating back to antiquity [8]. It has been shown via observation of animals that even chimpanzees use different plant types for their medicinal value [9].

For scientific, developmental, health-giving, and biological reasons, the risk posed by heavyweight metals is becoming more urgent. The term "heavyweight metals" is used to refer to any dense metallic component that is harmful at even trace amounts [10]. Metals and metalloids with densities more than 4 g/cm3, or five times that of water, are grouped together under the umbrella name "heavyweight metals" [11]. When compared to their density, the chemical properties of the heavyweight metals continue to be the most important factor. Lead, cadmium, nickel, cobalt, iron, zinc, chrome, arsenic, silver, and platinum are all examples of heavy metals [12]. In light of rising public concern over Earth's degenerating state, a consolidated vocabulary has developed to describe trace heavy metals. Herbal plants, animals, and humans all need a variety of minerals and metals to function normally, although the latter, known as "trace metals," include both necessary and non-essential elements and might be seen of as "primary" ingredients (plus poisonous elements) [13].

Heavy metals such as iron (Fe), copper (Cu), and zinc (Zn) are required for plant and animal life. Metals including Cu, Zn, Fe, Mn, Mo, Ni, and Co are important micro-nutriment[14] with variable availability in medium and absorption exceeding plant needs resulting in hazardous consequences [15, 16]. Due to their low concentrations in environmental matrices, these substances are sometimes referred to as trace or ultra-trace elements (0.010 g kg-1 or g l-1) respectively. Heavy metals including copper, zinc, iron, manganese, and molybdenum are required for a wide variety of biochemical and physiological processes in all living organisms. Heavy metals have two main purposes: (a) as part of redox reactions, and (b) as direct contributions to enzymes. Heavy metal pollution may come from both natural and human causes; for example, large swaths of the earth are being contaminated by mining, (smelting), and purifying processes, as well as farming. Heavy metals, such as cadmium, copper, and zinc, are a problem in many parts of the world, including Japan, Indonesia, and China (Herawati, Suzuki, Hayashi, Rivai, and Koyama, 2000); northern Greece (Zantopoulos, Antoniou, and Nikolaidis 1999); areas of Albania [17]; and the Australian region [18] (chromium, lead, copper, Nickel, zinc, and Cadmium). Since these elements are formed inside the planet itself, their presence in soil is mostly a byproduct of the weathering process.

When compared to other sedimentary rocks like limestone or sandstone, shale sedimentary rock contains the highest concentrations of the elements Cr, Mn, Co, Ni, Cu, Zn, Cd, Sn, Hg, and Pb. Large quantities of Al, Zn, Mn, Pb, Ni, Cu, and Hg, in addition to harmful and destructive gases, have been observed from volcanic eruptions [19]. Particularly lacking is global data on the release of heavy metals from consistent sources [20]. Sand carried by the wind from deserts, such the Sahara, has high concentrations of Iron (Fe), along with smaller levels of Cr, Ni, Mn, Pb, and Zn [21]. Transport of heavy metals is also significantly affected by pressurised canned goods and forest fire. Similar to the widespread attention paid to the transmission of sand particles, particularly those originating from the Sahara Desert [22], the detection of particles being transported from their origins in the Asia-Pacific, the Arctic, and the Antarctic has also attracted a lot of interest [23]. The weathering of parent rocks and the process of pyogenesis [24] have been linked to the presence of heavy metals with non-humanoid origins at ground level. Regardless, human activities have led to a dramatic increase in the amounts of a few heavy metals in some ecological populations [25].

When exposed to the right air conditions, heavy metals present as cations strongly interact with the soil surface and become active [26].Plants are able to store heavy metals in their tissues due to their ability to absorb potentially harmful ions from the air [27].

Understanding how heavy metals progress in food systems and the effects of such components on living things is of paramount relevance [28]. Heavy metal ion uptake by vegetation may increase the capacity of some toxic components entering the foodstuff chain.

Heavy metals have been known to have detrimental effects on human health for quite some time, however exposure levels have recently been shown to be higher in certain places [29].

Because heavy metals are so common in the environment, plants that promote healing are also able to take in their traces [25]. Heavy metal contamination of medicinal plants has been explained in three primary ways: during production, via incidental cross-pollution during handling, and through the deliberate presentation of heavy metals for purported therapeutic reasons [30].

Use of Hg in gold mining and subsequent release of accumulated high levels of Hg from abandoned mines have become a significant source of this environmental hazard. Since 1960, this customary procedure has been almost forgotten. Currently, it has spread to more than 10 million people throughout the tropics, mostly in Latin America, the United States, and Asia [31]. Metal dust and vapour frames are transmitted during high-temperature processing of heavy metals, such as purification and moulding. Combining heavy metal vapours with aqueous media results in the formation of aerosols. These might contaminate the ground or the water supply by being dispersed in the air (waterless testimony) or by being promoted in precipitation (misty affirmation) [32]. Processing plastics, materials, tiny electronics, preserving wood, and preparing rags are some examples of additional mechanical resources. Because of the high concentration of Cu in the soil beneath the power line, brushing animals are thought to be put to death by the pollution of the plants that grow there [33]. This article introduces a study that looks at the many causes of pollution from heavy metals, how that pollution affects the effectiveness of medicinal herbs, and the negative connotations it leaves with the general public.

MATERIALS AND METHODS

Astragalus auganus (Bunge), Cardaria chalepense (Linnues), Hertia intermedia (Boiss), Scorzonera ammophila (Bunge), and Tamarix karelini (Bunge)] were chosen as five of the local medicinal plants in the study area of Turmic Valley, Gilgat Baltistan, to determine selected heavy metals (Cd, Cu, Ni, Pb, and Zn).

Sample Collection

A powder form of each plant was obtained by drying and crushing fresh specimens taken from various locations across Turmic Valley and placing the resulting powders in bottles.

Procedures and methods

Using AAS, a stock solution of 1000 ppm of each chosen heavy metal is made (Cd, Cr, Cu, Pb and Zn). The concentration of the heavy metal in the sample solution is calculated using the appropriate calibration curve. Zinc nitrate $Zn(NO_3)_2$, copper nitrate $Cu(NO_3)_2$, lead nitrate $Pb(NO_3)_2$, chromium nitrate $Cr(NO_3)_2.2H_2O)$, and cadmium nitrate $Cd(NO_3)_2$ were dissolved in deionized water to create calibration curves. Both a default and a control solution were planned out in advance. Every solution was made in the same way: 10 ml of standard Zn, Cu, Pb, Cr, and Cd stock solutions were pipetted into 100 ml calibrated flasks, and then the contents were diluted with deionized water and carefully mixed. Working solutions were created by pipetting 100 ppm into calibrated flasks and then topping them up with deionized water to the desired volume.

Standard solutions preparation

In this case, Zn, Cu, Pb, Cr, and Cd were the heavy metal cations of choice. Calibration curves were made using solutions of zinc nitrate $Zn(NO_3)_2$, copper nitrate $Cu(NO_3)_2$, lead nitrate $Pb(NO_3)_{32}$, chromium nitrate $Cr(NO_3)_3.2H_2O)$, and cadmium nitrate $Cd(NO_3)_2$. There was forethought put into both a fallback and a regulation option. These norms were organised as follows, based on the dilution of a 1000ppm stock solution preparation: Zinc at 0.5, 1, 1, 1.5, 2, and 2.5 ppm; Copper at 0.1, 0.5, 1, 1, and 2 ppm; Lead at 0.5, 1, 1, 1, 1.5, 2, and 2.5 ppm; Chromium at 0.2, 0.4, 0.6, 0.8, 1.0, and 1.25 ppm; and Cadmium at 0.2, 0.4, 0.6, 0.8, 1.0, and 1.2 ppm. By comparing absorbance to the concentrations of metallic particles, fitting curves were developed for the elements Zn, Cu, Pb, Cr, and Cd.

Samples preparation

Digestion of samples

In a round-bottomed container equipped with a condenser, 0.5 gramme of plant powder was mixed with 5 millilitres of nitric acid and 15 millilitres of hydrochloric acid. The material is boiled for 6-8 hours to create a response. Next, 25 ml of deionized water was added, and the solution was filtered using Whatman No. 1 Filter Paper. After that, deionized water was added to bring the total volume of the filtrate up to the specified level.

Optimization for digestion procedure

The primary goal of sample prep for analysis is to provide a favourable environment for digestion. The ideal situation calls for a minimal amount of reagents, a brief period of time during which to reflect on the digestive process, a transparent digesting solution, little effort, minimal complexity, and no remaining undigested powder in the sample. Here, we investigate the effects of altering the amount of HNO_3 and HCl acid mixes, the duration of the digestion process, and the temperature of the digestion in order to get a clear, colourless sample solution appropriate for AAS analysis. To find the best circumstances for digesting a 0.5g powder sample, researchers used a variety of approaches. As determined by the optimization process, the best conditions for the digestion of 0.5g powder plant samples are an acid combination of 5 ml of HNO3 (69-72%) and 15 ml of HCl (70%), a digestion period of 6-8 hours, and a digestion temperature of 100c.

Digestion of powder plants samples

Under the new conditions, half a gramme of the dried, homogenised, and active plant material was placed in a 100 mL round-bottom flask, mixed with 5 mL of a mixture of 69-72% hydrogen peroxide and 15% hydrogen chloride in a volume proportion of 5:15 (v/v), and heated to 100 °C in the flask fitted with a reflex condenser for 6-8 hours. It was decided to let the treated specimen cool to room temperature. The resulting digested residue was diluted with distilled water and filtered using Whatman filter paper No. 1. The volume of the filtrate was adjusted to 100 ml using distilled water before AAS measurements of Zinc (Zn), Copper (Cu), Lead (Pb), Chrome (Cr), and Cadmium (Cd) were performed. Both blanks were digested three times. Samples of powder and a reagent blank were digested simultaneously under the same conditions.

Concentration of metals by AAS

Creating a Calibration Curve

By dissolving a standard quantity of each metallic salt in 100 ml of purified water and diluting to 100 ml, stock solutions of (1000mg/l) of each metallic ion were prepared. Each stock solution was diluted successively to create 6–7 standard solutions. To determine the point of metal convergence, adjustment bends were installed in the illustrative setup. It took six sets of working measurements to properly position the instrument. Each metal's moderate standard arrangement, at 10 mg/l, was used to establish its working standard arrangement. By charting absorbance as a function of metal particle standard fixation, an alignment bend was established for each metal particle to be analysed.

Determination of metal contents

By measuring the absorbance of the metal particles in the sample with AAS and comparing the results to a defined standard adjustment curve, we were able to effectively manage the particle sorting. Zn, Cu, Pb, Cr, and Cd were analyzed using an AAS fitted with a deuterium circular segment back ground corrector and a standard air acetylene fire framework with an outside adjustment bend, after optimizing the instrument's parameters (burner and light arrangement, cut width, and wave length change) for minimum flag power. Each case was analyzed three times, with the same result each time. When operating at its critical source line, manufacturers recommended using empty cathode lamps under certain situations. It was determined how much acetylene to use and how fast the wind should blow in order to create the ideal circumstances for a fire. Assimilation/focus mode was used to regulate the metals, and the instrument readout was physically recorded for each configuration. The components in processed clear arrangements were guaranteed using the same logical manner as the spiking examples.

Flame Atomic Absorption Spectrophotometric Analysis

The method described in [34] was used to quantify zinc, copper, lead, chromium, and cadmium. Samples of similar brands will be properly mixed before analysis to ensure that the data is representative of the whole. Zn, Cu, Pb, Cr, and Cd concentrations were determined by AAS in the digested samples. By referencing the measured absorbance to its appropriate standard, the concentration of each metal was determined (calibration curve). FAO/WHO tentative acceptable weekly intake was used to compare average concentration to safe levels (JECFA).

Method Validation

Precision and accuracy

Accuracy and precision are perhaps the most critical words to use when describing the magnitude of mistakes in an analytical result. Best reported and established values need an assessment of outcomes to determine error bars [34]. Precision (the capacity to reliably reproduce findings) and accuracy (the degree to which a collection of outcomes for the same quantity agree with one another) are of paramount importance to the analyst [34]. The standard deviation, relative percentage, variance of a set of data are often used to describe the accuracy of an analytical technique in this field of research [35]. The precision of three samples (N=3) was analysed using the percentage relative standard deviation of the data and triplicate readings for each sample, for a total of nine measurements for a single bulk sample. Similarly, the validity and reliability of the measures were established by the examination of representative samples.

Method detection limit

The standard deviation of the blank solution multiplied by a constant gives a good approximation of the detection limit of a specific technique; this is the smallest amount of analytic sample that can be distinguished from stochastic variations in the blank. Typically, researchers choose a signal strength that is three times larger than the blank's standard deviation as the limit of detection [36]. The standard deviation of the three measurements for each blank was determined following the digestion of three HNO3 and HCl blank solutions in this investigation. By tripling the standard deviation of the reagent blank, we were able to calculate the detection limit of each element for this approach. MDL= 3 x δ, when all values are blank, the SD is denoted by blank.

Limit of quantitation (LOQ)

Limit of quantitation refers to the lowest concentration level at which a result is still statistically significant (LOQ). [37]. LOQ was determined by analysing nine blank reagents in triplicate that were digested using the same method as the powdered plant samples. Multiplying the pooled standard deviation of the reagent blank by 10 yielded the LOQ (LOQ =10 x SD blank ,n=3).

Optimized procedure's validation

Due to a lack of certified reference materials (CSRM), it was not feasible to directly determine the validity of the aforementioned improved process towards examination of the powder plants samples with regard to each of the chosen metals (Zn, Cu, Pb, Cr, and Cd). Instead, the spiking approach was used to the aforementioned [38] digesting process to get the same result. So, the improved technique was tested by mixing varying amounts of standard solutions comprising 10 mg/L of each element into a powder sample weighing 0.5 g. Next, the boosted samples underwent the same digestion process as the unadulterated ones. The digests were diluted to the proper concentration with deionized water before being transferred to a 50 ml volumetric flask. The concentration of metals in the solutions was finally determined using FAAS. Tripartite spiked testers were set, and their results were recorded, in the same manner as the original testers. As a result of utilising the following formula, we were able to determine the amount of recovery.

$$R = \frac{\mathrm{Cs} - \mathrm{c}}{\mathrm{s}} \mathrm{x}\ 100\%$$

Where s = concentration equivalent of analyte added to sample, c = concentration of metal in non-spiked sample, and R = percentage of metal recovered from sample where Cs = concentration of metal in spiked sample.

The metal composition of digests

The concentration of treated, digested samples was analysed using Single Atom Absorption Spectroscopy with various parameters.

Data analysis

Microsoft Office Excel 365 was used for the data analysis. Statistics were used to describe the data, and the Mean was used to summarize the numerical information.

RESULTS AND DISCUSSION

Therapeutic herbs with concentrations of trace heavy metals that are over the regulatory limit are a major cause for public safety concerns across the globe. Because of lax and improper regulation of quality assurance criteria of plants that form the raw materials for the completed medicinal items, this issue is much more significant and worrying in Pakistan. Five medicinal plants viz., Astragalus auganus, Tamarix karelini, Cardaria chalepense, Scorzonera ammophila, and Hertia intermedia were among the medicinal plants tested for their levels of five heavy metals (Cd, Cu, Ni, Pb, and Zn) in the current investigation. Atomic absorption spectrometry [39], the most widely used analytical technique for assessing trace metals in biological materials, was used to calculate the metal concentrations in the aforementioned plants. All of the targeted heavy metals were detected in the medicinal plants analysed in this investigation.

Table 4.1 Heavy metals levels (ppm) in tested plants

Heavy Metals	Medicinal plants				
	Hertia intermedia	*Cardaria chalepense*	*Scorzonera ammophila*	*Tamarix karelini*	*Astragalus auganus*
Cd	0.0081	0.0122	0.0338	0.0116	0.0051
Cu	2.0347	1.1587	1.1878	1.5898	0.8234
Ni	0.2418	0.4692	0.2378	0.1182	0.1088
Pb	0.3094	0.0973	0.0178	0.2509	0.0254
Zn	4.5291	2.3683	3.1163	3.9359	2.7498

Cadmium (Cd)

Scorzonera ammophila had the highest content of cadmium (Cd) among the examined medicinal plants, at 0.0338 ppm, followed by Cardaria chalepense (0.0122ppm). Cd levels were also measured and determined to be 0.0116 ppm in Tamarix karelini, 0.008 ppm in Hertia intermedia, and 0.0051 ppm in Astragalus auganus (Table 1 & Figure. 1). The maximum allowable level of Cd in food crops is 0.21 parts per billion, according to the World Health Organization and the Food and Agriculture Organization [40]. However, Canada and China have adopted a WHO-recommended Cd limit of 0.3 ppm. While Canada has also established allowable limitations of 0.006 mg/day in finished herbal products derived from raw medicinal plant material (WHO, 2005b). We found that the Cd levels in all of the plants we tested were well under the acceptable limits set by [40] and the World Health Organization [41], therefore our results indicate that any of the plants from this region might be used safely in herbal medicine. Differences in plant species and location—Haripur being a densely populated region influenced more by human activities than the Turmic Valley area—may account for the discrepancy between the study's findings and those of [42].

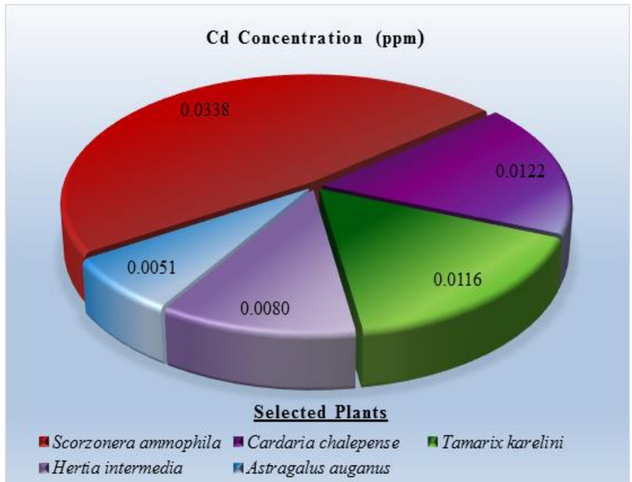

Figure 1: Cd level in tested plants

Copper (Cu)

Hertia intermedia had a concentration of copper (Cu) heavy metal of 2.0347 ppm, whereas other medicinal plants had values of 1.5898 ppm, 1.1878 ppm, and 1.0347 ppm, respectively (1.1587ppm). Astragalus auganus (0.8234ppm) was found to have the lowest computed ppm of Cu (Table 1 & Figure.2). Per [40], 3.00 ppm of Cu is safe for consumption in plants used for food. We compared the levels of metals found in the researched medicinal plants to the safe levels of copper established by Singapore and China [43]. It's hypothesised that plants collect Cu at very low rates. Ghaderian [44] reported a wide variation in Cu concentration in plants from the copper mining region of Iran, with values ranging from 2 g/g in the therophyte Erodium sp. to 1581 g/g in the geopyhte Epilobium hirsutum L. This disparity suggests that most therophytes in the region have lower Cu content than the various geophytes. In contrast to [44], we found a much narrower range of Cu content in our therophytes (H.intermedia, C. chelapens, and S. ammophila), which may suggest that therophytes are non-accumulators for Cu. However, our solitary geophtyte (Astragalus auganus) showed very contrasting Cu content as compared to most of their studied plants. The high level of Cu content in the Iran mining region is likely to blame for the high levels of unfamiliarity seen in both investigations.

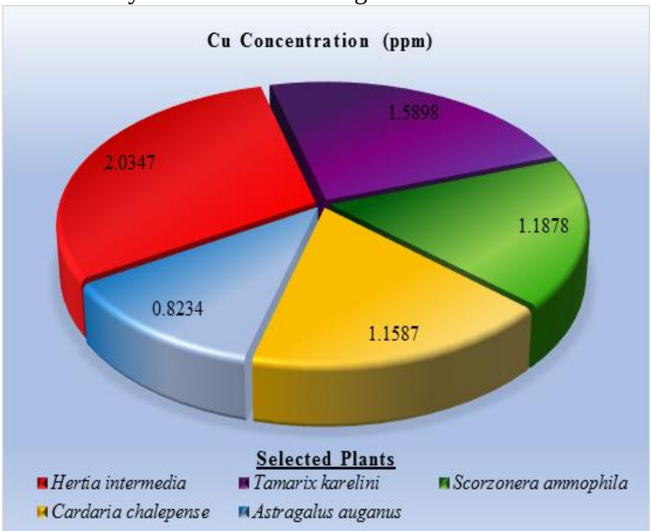

Figure 2: Cu level in tested plants

Nickel (Ni)

Ni was found at a range of concentrations in different plants, with the highest value being 0.4692 ppm in Cardaria chalepense, followed by 0.2418 ppm in Hertia intermedia, 0.2378 ppm in Scorzonera ammophila, and 0.1182 ppm in Tamarix karelini, and finally 0.1088 ppm in Astragalus auganus (Table 1 & Figure. 3). As of [43], 1.63 ppm of Ni was deemed safe for consumption in plants used for human use. Even said, the [44] has not yet established Ni limitations for medicinal plants. Ni concentrations in the plants used in this investigation were much lower than the thresholds suggested by[43]. While our plants' Ni content is lower than that reported by Jabeen [42], all the plants in their study accumulated Ni at levels higher than the earliers.

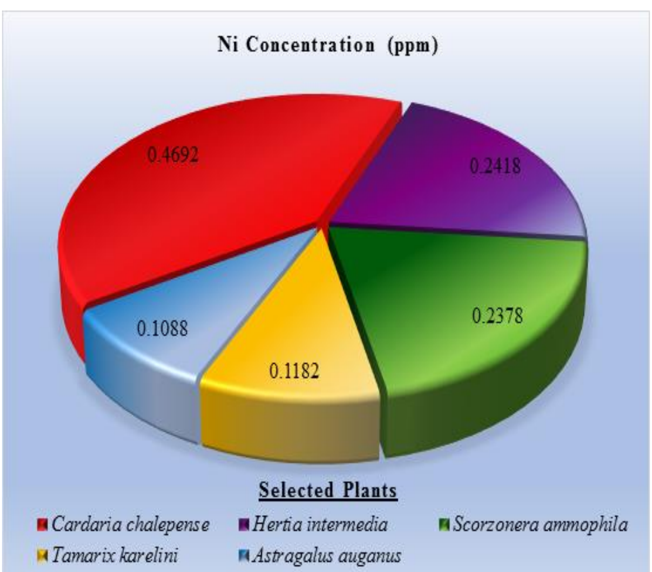

Figure 3: Ni level in tested plants

Lead (Pb)

Hertia intermedia had the highest lead Pb content (0.3094 ppm) of the medicinal plants tested, followed by Tamarix karelini (0.2509ppm). Cardaria chalepense (0.0973ppm) and Astragalus auganus (0.0254ppm) had the next highest and lowest Pb values among the medicinal plants investigated, respectively, while Scorzonera ammophila (0.0178ppm) had the lowest (Table 1 & Figure. 4). Pb levels in edible [43] plants were deemed acceptable by [42] to be no more than 0.43 ppm. In contrast, the World Health Organization (WHO), China, Canada, Malaysia, and Thailand have all upped this restriction to 10 ppm for medicinal plant components, and Canada has additionally established 0.02 mg per day as an allowable maximum in finished herbal products (WHO, 2005b). To yet, the Pb contents of the examined medicinal plants have been determined to be well within the guidelines recommended by[44]. shirin [45] observed a Pb high ppm level beyond the specified limit in many areas of Withaniasomnifera, indicating that W. somnifera may collect more Pb than the plants we tested. All of the plants we tested for Pb content corroborated our results, with the exception of A.occidentale and A.indica, both of which had Pb levels that were too high for human consumption [46, 43].

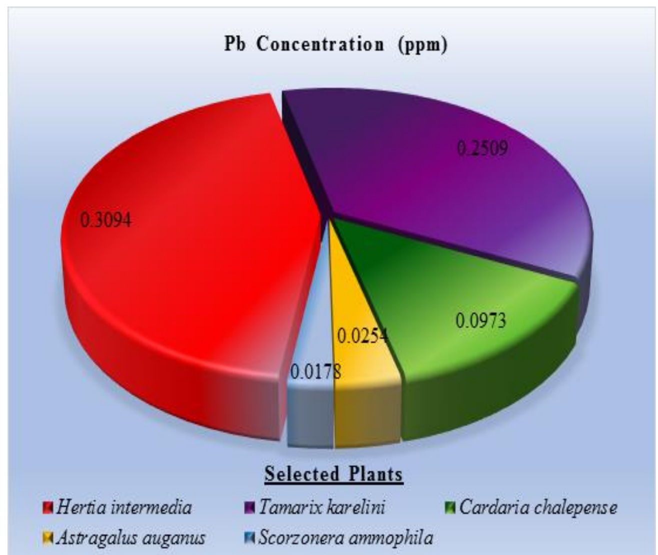

Figure 4: Pb level in tested plants

Zinc (Zn)

Hertia intermedia was found to have the greatest concentration of zinc (Zn) heavy metal (4.529 ppm), whereas Tamarix karelini (3.9559 ppm), Scorzonera ammophila (3.1163 ppm), and Astragalus auganus (3.1166 ppm) were also measured (2.7498ppm)., Cardaria chalepense had the lowest Zn content, at 2.3683 ppm (Table 1 & Figure. 5). For Zn, [43] established a maximum value of 27.4 ppm as being safe. Zn content limits for therapeutic plants have not been determined, however [43]. All of the plants we tested contain acceptable levels of Zn for medicinal use, as determined by comparing their content to the allowed limits provided by [43]. In the case of Zn, our findings were likewise diametrically opposed to those of [46], a discrepancy that may be attributable to the fact that different plant species accumulate different amounts of this essential element for their metabolism.

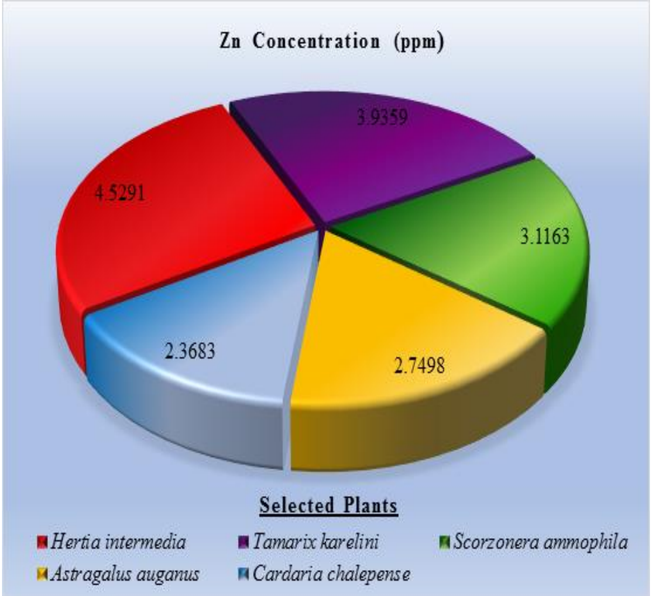

Figure .5: Zn levels in tested plants

Hertia intermedia had the highest Zn concentration among the chosen medicinal plants at 4.5291 ppm, followed by Tamarix karelini at 3.9359 ppm, Scorzonera ammophila at 3.1163 ppm, and Astragalus auganus at 2.7498 ppm, with Cardaria chalepense having the lowest at 2.3683 ppm. Scorzonera ammophila had the highest Cd content (0.0338 ppm), followed by Cardaria chalepense (0.0122 ppm), Tamarix karelini (0.0116 ppm), Hertia intermedia (0.0080 ppm), and finally Astragalus auganus (0.0051 ppm). Hertia intermedia had a Cu content of 2.0347 ppm, followed by Tamarix karelini (1.5898 ppm), Scotzonera ammophila (1.1878 ppm), Carderia chelapense (1.1587 ppm), and Astragalus auganus (0.8234 ppm). Among the several medicinal plants tested, Hertia intermedia had the highest Pb concentration at 0.3094ppm, followed by Tamarix karelini (0.2509ppm), Cardaria chalepense (0.0973ppm), Astragalus auganus (0.0254ppm), and Scorzonera auganus (0.0178ppm). Carderia chelapense has the highest estimated Ni content at 0.241, followed by Tamarix karelini (0.469), Scorzonera ammophila (0.238), Tamarix karelini (0.118), and Astragalus auganus (0.110). (Table 1 & Figure 6).

Zinc had the highest ppm concentration value across all plant species, followed by copper, nickel, and lead, although cadmium was present in all plant species, albeit at very low quantities.

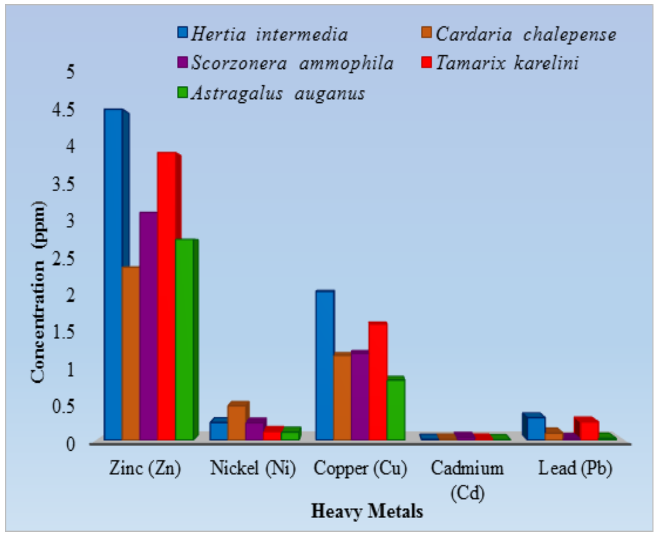

Figure 6: Comparative ppm concentrations of heavy metals in selected plants.

CONCLUSION

Each of the five chosen medicinal plants has been proposed as a treatment for a wide variety of conditions in conventional medical literature. In the last several decades, there has been a lot of development in the scientific assessment of medicinal plants used in phytotherapy. The World Health Organization's monographs, as well as the pharmaceutical and herb dealing sectors at the national level, are all places where the shifting climate is having a tangible effect.

The present study found that the plant samples contained significant amounts of the metals analysed, though the levels of some metals for the samples varied greatly; this discrepancy may have resulted from the chemical composition of the plant parts, the specific environmental conditions under which the plants were grown, or the fact that the soils in the areas studied contained a lower concentration of mineral nutrients.

According to the data reported here, the plant samples' measured concentrations of the various metals are largely consistent with those found in other medicinal plants from throughout the globe. Researchers found that the medicinal plants they tested had tiny amounts of heavy metals that were well below safe levels. Scorzonera ammophila and Cardaria chalepense both had high concentrations of Cd (0.0338 ppm) and Ni (0.469 ppm), but Hertia intermedia was the sole species with elevated levels of Cu (2.035 ppm), Pb (0.309 ppm), and Zn (4.529 ppm). This study's findings provide preliminary evidence that the locally-grown plants sampled are edible. In other words, the deposition of the tested heavy metal on the plants indicates that these places are still relatively unpolluted. Standardized extracts of the medicinal plants of the study region may be employed in herbal remedies, provided they are harvested from environments free of heavy metal buildup.

RECOMMENDATIONS

It is proposed that a multidisciplinary approach be used with the full participation of local medicine practitioners from plants in order to get a deeper knowledge of the health related impact and chemical profile of medicinal plants. Since neighbouring medicinal plants are often negatively impacted by the use of fertilisers, pesticides, and other heavy metals spilled from various human activities. The research results from this method need to be weighed against the known risks associated with using or abusing medicinal herbs. In most cases, there are enough people making use of medicinal plants to cure various illnesses. The existing publications just concentrate on the beneficial and bad effects of medicinal plants on the country's economic, social, cultural, and agricultural worth. Some studies were also done on the organic and chemical sides of things. Nonetheless, the mineral composition of these healing plants has not been investigated. As a result, there is still a pressing need for research into its molecular profile and drawbacks. There is a need for further research on the bioavailability of harmful heavy metals in therapeutic plants.

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