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Screening of Heavy Metal Contents in *Heracleum persicum* (Golpar) from Selected Markets in Tehran

Parisa Ziarati[1]* and Niyousha Karbalaei Mohammad Persia Behbahani[2]

[1]*Chemistry Department, Pharmaceutical Sciences Branch, Islamic Azad University, Tehran, Iran*
[2]*Advanced Sciences & Technologies Faculty, Pharmaceutical Sciences Branch, Islamic Azad University, Tehran, Iran*

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Introduction

Heracleum persicum, known as Golpar or Persian Hogweed is a flowering plant. Its fruits are wildly used as spices and the plant is used medicinally to relieve flatulence, stomach aches as well as flavoring as a digestive and an antiseptic [1].

Medicinal plants have played a key role in world health. They are distributed worldwide, but they are most abundant in tropical countries. It is estimated that about 25% of all modern medicines are directly or indirectly derived from higher plants [2,3]. A vast number of plants have medicinal properties; in fact, many pharmaceutical drugs were originally derived from plants. Herbal materials and medicinal plants are also often used as food, functional food, nutritional or dietary supplements in many countries such as Iran.

Due to poverty and limited access to modern medicine, about four billion people, 80% of the world's population, living in developing countries use herbal medicine as their source of primary health care [4-6]. Natural products in medicine constitute a vast array of "raw materials", making important clear definitions. Quality criteria are based on clear scientific definitions of raw material. The term "herbal drugs" denotes plants or plant parts that have been converted into phyto-pharmaceuticals by means of simple process involving harvesting, drying, and storage [7]. The quality of a plant product is determined by the prevailing conditions during growth, and accepted Good Agricultural Practices (GAP) can control this. These include seed selection, growth conditions, and use of fertilizers, harvesting, drying and storage. In fact, GAP procedures are, and will be, an internal part of quality control. Apart from these criteria, factors such as the method of extraction, contamination with microorganisms, heavy metals, and pesticides can alter the quality, safety and efficacy of herbal drugs. Using cultivated plants under controlled conditions instead of those collected from the wild can minimize most of these factors [8,9].

By far, the majority of potentially hazardous contaminants and residues are found in the herbs and herbal materials. It has been reported herbal plant to contain significant quantities of some heavy metals, including Cadmium, Lead and Mercury. Exposure to trace and heavy metals above the permissible affects human health and may result in illness to human. As a general rule, heavy metal toxicity results in gastrointestinal irritation, renal toxicity and multi-organ toxicity. Thus, the analytical control of metals in plants, especially medicinal plants, is part of quality control, which should establish their purity, safety and efficacy, as a World Health Organization (WHO) recommended in a number of resolutions [10]. Furthermore, the European Commission has established the lead, cadmium and mercury limits in food supplements that have been in force since March 2001 [11].

The objective of this research was to determine the level of Cd, Pb, Zn, Ni, Cu and chromium in *Heracleum persicum* samples which purchased from Tehran markets.

Material and Methods

Sampling description

To examine the heavy metals and other metals level in *Heracleum persicum*, 10 samples were purchased from 10 different local herbal-markets in Tehran in 2011.

Estimation of Cd, Pb, Cr, Cu, Zn and Ni

For heavy metal analyses 5 gram of each sample was weighed and oven-dried at 60°C to a constant weight. Each oven-dried sample was ground in a mortar until it could pass through a 60 mesh sieve. The samples were stored in clean, dry, high density polyethylene bottles of 100 ml capacity with screw caps. All glassware and plastic containers used were washed with liquid soap, rinsed with water, soaked in 10% volume/volume nitric acid for 24hrs, cleaned thoroughly with distilled water and dried in such a manner to ensure that any contamination does not occur.

One gram of powdered sample was weighed precisely on electronic balance (Shimadzu LIBROR AEX 200G) The samples were put in a 100 ml digestion flask and 5 ml of mixture was added to it and heated on a hot plate in the fuming chamber. A digestion mixture comprising of concentrated HNO_3 and hydrochloric acid in the ratio of 6:1 was used for wet digestion of the samples. Blanks and samples were also processed and analyzed simultaneously. All the chemicals used were of analytical grade (AR).

Standardized international protocols were followed for the preparation of material and analysis of heavy metals contents. The flasks were firstly heated slowly and then vigorously till a white residue is obtained. The residue was dissolved and made up to 10 ml with 0.1 N HNO_3 and NH_4I solution in a volumetric flask. The samples were analyzed by an Flame Emission Spectrophotometer Model A A-6200 (Shimadzu, Japan) using an air-acetylene flame for heavy metals – Pb, Cd, Cr, Ni, Zn and Cu, using at least two standard solutions for each metal. All necessary precautions were taken to avoid any possible contamination of the sample as per the AOAC guidelines [12].

***Corresponding author:** Parisa Ziarati, Pharmaceutical Sciences Branch, Islamic Azad University, Tehran, Iran, E-mail: waboponejosue@yahoo.fr

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Calibration of equipment

Standard solutions of heavy metals (1000 mg/L), namely Copper (Cu), Zinc (Zn), Chromium (Cr), Cadmium (Cd), Lead (Pb) and Nickel (Ni) were procured from Merck. Solutions of varying concentrations were prepared for all the metals by diluting the standards. For the elements under investigation we established the following sensitivity and detection limits respectively of the used FAAS apparatus. Pb 0.2 and 1.0 ppm, Cr 0.5 and 3.0 ppm, Cd 0.2 and 1.0 ppm, Cu 0.5 and 3.0 ppm, Zn 0.05 and 5.0 ppm, Ni 0.5 and 4.0 ppm.

Results and Discussion

A total of 6 elements (Zn, Ni, Cd, Cr, Cu and Pb) were determined in the powdered Iranian *Heracleum persicum* samples and all samples were analyzed three times. Each data present mean content ± SD of 60 samples. All results were calculated on a dry weight basis (mg/kg dry weight).

Table 1 shows the mean content ± SD of various heavy metals and various elements in investigated Iranian *Heracleum persicum* samples purchased from Tehran's markets in 2011.

Lead

The main cause for concern in terms of contamination of *Heracleum persicum* by heavy metals relates to Lead (Pb). Lead concentration ranged from 29.91 ± 0.02 mg/kg to 33.46 ± 0.04 mg/kg. 100% of 180(quality controlled) samples from Tehran's markets contained Pb concentrations that exceeded the permissible limit by WHO [13]. Prescribed limit for Pb contents in herbal medicine is 10 mg/kg dry weight while the dietary intake limit for Pb is 3 mg/week. Lead is known to cause neurological disorders, anemia, kidney damage, miscarriage, lower sperm count and hepatotoxicity in higher concentration [14].

Cadmium

The other major cause for concern in terms of contamination of *Heracleum persicum* samples relates to Cadmium. Cadmium ranged from 4.87 ± 0.05 mg/kg to 11.37 ± 0.02 mg/kg. 100 % of the samples analyzed showed Cadmium concentrations that exceeded the permissible limit by the European Commission Regulation (EC) [11]. WHO [13] prescribed limit for Cd contents in medicinal plant is 0.3 mg/kg and the maximum acceptable concentration for food stuff is around 1 ppm [15]. Cd intoxication can lead to kidney, bone and pulmonary damages [16].

Nickel

Nickel ranged from 15.77 ± 0.07 mg/kg to 25.66 ± 0.03 mg/kg. The most common ailment arising from Ni is an allergic dermatitis known as Nickel itch, which usually occurs when skin is moist; furthermore Ni has been identified as a suspected carcinogen and adversely affects lungs and nasal cavities. Although Ni is required in minute quantity for body as it is mostly present in the pancreas and hence, plays an important role in the production of insulin. EPA has recommended daily intake of Ni should be less than1mg beyond which is toxic [17].

Copper

Although Cu is an essential enzymatic element for normal plant growth and development but can be toxic at excessive levels, WHO limits for Cu have not yet been established for herbal plants. Phytotoxicity can occur if its concentration in plants is higher than 20-100 ppm DW (dry weight). As can be seen from the data (Table 1) Cu ranged from 5.44 ± 0.05 mg/kg to 11.27 ± 0.06 mg/kg. There is no permissible limit prescribed in local food law or by WHO, but WHO (1996) has recommended the lower limit of the acceptable range of Cu as 20 µg/mg body weight per day [18,19] however, national limits in Singapore for herbal medicines and products is 150 ppm.

Chromium

The mean concentration of Cr (Table 1) found in different samples as 31.55 mg/kg DW and Cr level was found from 29.47 ± 0.04 mg/kg to 36.72 ± 0.07 mg/kg. It was higher than permissible limit of 0.5 ppm as set by FDA [20]. However, for medicinal plants the WHO limits are not yet been established for Cr. Although in medicinal plants, permissible limits for Cr set by Canada were 2mg/kg in raw medicinal plant material. The higher concentration of Cr than the critical level 5.30 ppm could be a probable cause for yields reduction. The toxic effects of Cr intake is skin rash, nose irritations, bleeds, upset stomach, kidney and liver damage, nasal itch and lungs cancer, chromium deficiency is characterized by disturbance in glucose lipids and protein metabolism [17].

Zinc

As evident from table 1, mean concentration of Zn was found in our samples as 33.50 mg/kg DW and Zn level was from 36.19 ± 0.17 mg/kg to 44.22 ± 0.11. Zinc is an essential trace element for plant growth and also plays an important role in various cell processes including normal growth, brain development, behavioral response, bone formation and wound healing. For medicinal plants, the WHO limits are not yet been established for Zn. The dietary limit of Zn is 100 ppm [21], therefore, it was far below the permissible limit.

From the study, it was revealed that Lead and Cadmium contents in all samples exceed from permissible WHO

Levels Figure 1 shows the mean content of various elements in

Metal	Min.	Max.	Mean.	WHO
Pb	29.91 ± 0.02	33.46 ± 0.04	31.21 ± 0.04	10
Cd	4.87 ± 0.05	11.37 ± 0.02	9.67 ± 0.03	0.3
Ni	15.77 ± 0.07	25.66 ± 0.03	22.96 ± 0.12	
Zn	36.19 ± 0.17	44.22 ± 0.11	41.79 ± 0.15	100
Cr	29.47 ± 0.04	36.72 ± 0.07	34.26 ± 0.05	2
Cu	5.44 ± 0.05	11.27 ± 0.06	8.11 ± 0.06	100

Table 1: Mean content ± SD and minimum and maximum of metals (mg/kg DW) in *Heracleum persicum* (GOLPAR) samples purchased from Tehran-Iran markets in 2011.

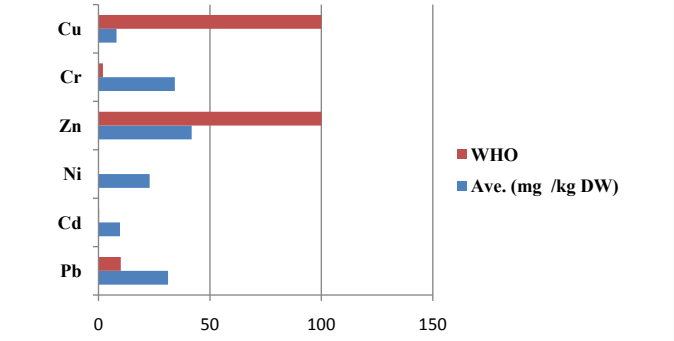

Figure 1: Average metal contents in *Heracleum persicum* samples in Tehran, 2011.

investigated samples of *Heracleum persicum* in different seasons in comparison with WHO permissible levels [13].

Conclusion

Concentration of essential and non-essential heavy metals in medicinal plants beyond permissible limit is a matter of great concern to public safety all over the world. The problem is rather more serious in Iran, because medicinal plants are neither controlled nor properly regulated by quality assurance parameters.

With the exception of fall out of atmospheric pollutants through rain and accumulation in plant, it is probable that the metal was translocated through air dust blowing from nearby. The research indicates that:

• Consumers are purchasing *Heracleum persicum* with high levels of heavy metals (HMs).

• The results suggest that medicinal plants used for human consumption or for preparation of herbal products and standardized extracts should be collected from an unpolluted natural habitat.

• There is no regular testing of heavy metals in Herbal plants by the designated authorities in Iran.

• By a comparison between acceptable global standards and the level of Cadmium and Lead on investigated herbal medicines, our results showed that the quantities of these heavy metals in all of samples with lower quality were higher than acceptable intake recommended by global standards. Considerable attention for alternative therapy should be done especially for patients who may intake these herbal medicines for a long time.

• It is recommended that the relevant authorities need to supervise the market to ensure the unsafe ingredients medicinal plants are below the recommended permissible before granting sale permission.

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