

Comparing Heavy Metal Contents of *Panax Ginseng* Samples from Selected Markets in Tehran and Beijing

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Abstract

Introduction: *Panax Ginseng* C. A. Meyer, belonging to the Araliaceae family, is a perennial plant with fleshy roots that grows in Korea and northern China. *Panax Ginseng* has been regarded as a medicinal plant in traditional oriental medicine. The root of *Panax Ginseng* is commonly used as herbal medicine. However, little is known about the contents and origin of heavy metals in the samples of herbal plants being sold in local herbal markets in Iran. The objective of the present research was to determine the level of Cadmium, Lead, Zinc, Nickel, Copper and Chromium contents in *Panax Ginseng* samples purchased from Tehran and Beijing local herbal markets and to find the possible process of contamination.

Material and methods: To examine these metal contents in *Panax Ginseng*, 100 samples from Tehran and 100 samples from Beijing local herbal markets were purchased from 20 and 25 different local herbal markets in Beijing and Tehran respectively in 2012. A certain weight of each sample was determined and then analyzed by atomic absorption spectrophotometer. The concentration levels of heavy metals on the samples were determined as mean \pm SD (mg/kg dry weight) of three replicates in each test.

Results: Results showed a significant increase in lead, Cadmium and Chromium contents in Tehran's markets compared to the samples purchased from Beijing markets ($p < 0.05$). Since the amount of heavy metals in the ginseng samples obtained from Iranian markets is much higher than the corresponding figure in the ginseng supplied in the Chinese markets.

Discussion: It may be concluded that the ginseng samples could be contaminated in different stages of transportation and storage. The contamination of medicinal herbs by toxic heavy metals results in serious safety issues due to the increasing popularity of herbal remedies in the world. Therefore, it is critical to analyze heavy metals in herbal medicine in order to assure that the levels of heavy metals do not exceed the required limits established by regulations.

Keywords: Heavy metals; *Panax Ginseng*; Herbal markets; Tehran; Beijing

Introduction

Panax Ginseng C. A. Meyer, belonging to the Araliaceae family, is a slow-growing perennial plant with fleshy roots that grows in Korea and northern China. For a long time, *Panax Ginseng* has been regarded as a medicinal plant in traditional oriental medicine [1,2]. The biological and pharmacological efficacy of this plant has been revealed by modern science. Such healing characteristics of this herb include improving brain function, adaptogenic effects, pain-relieving effects, preventive effects against tumors and anti-tumor activity, enhancing immune system function, anti-diabetic effects, enhancing liver function, adjusting blood pressure, anti-fatigue and anti-stress effects, improving climacteric disorder and sexual functions, as well as anti-oxidative and anti-aging effects [3-6].

The ingredients of ginseng root have been investigated and several classes of compounds have been detected such as triterpene saponins; essential oil-containing polyacetylenes and sesquiterpenes; polysaccharides; peptidoglycans; nitrogen-containing compounds; as well as various ubiquitous compounds such as fatty acids, carbohydrates, and phenolic compounds [7]. *Panax Ginseng* contains an extraordinarily complex mixture of chemical constituents that can vary with species of the herb, place of origin, and growing conditions. Although different ginseng species may be used slightly differently in traditional medicines, all species contain ginsenosides as active components and most of the pharmacological activity of ginseng can be attributed to these compounds. Ginsenosides are specific

types of triterpene saponin, a broad group of chemical compounds. Ginsenosides are found nearly exclusively in *Panax* species (ginseng) and up to now more than 150 naturally occurring ginsenosides have been detected and extracted from different organs of ginseng [8]. Ginsenosides appear to be responsible for most of the activities of ginseng including ant carcinogenic, immunomodulatory, anti-inflammatory, anti-allergic, anti-atherosclerotic, antihypertensive, and anti-diabetic effects as well as anti-stress activity and effects on the central nervous system [9]. The root of ginseng is a commonly used herbal medicine [10]. However, little is known about the contents and origin of heavy metals in samples of herbal plants being sold in local herbal markets in Iran.

The quality of a crop is determined by the prevailing conditions during growth and can be controlled and tested by the accepted Good Agricultural Practices (GAP). Such controls include seed selection, growth conditions, use of fertilizers, harvesting, drying and storage. In

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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 [11,12].

By far, the majority of potentially hazardous contaminants and residues are found in the herbs and herbal materials. It has been reported that herbal plants contain significant quantities of some heavy metals, including cadmium, lead and mercury. Exposure to traces of abovementioned heavy metals may affect human health and result in serious illnesses. 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. Such controls are to establish their purity, safety and efficacy, as a World Health Organization (WHO) recommended in a number of resolutions. Furthermore, the European Commission has established some standard limits for the lead, cadmium and mercury contents in food supplements that have been in force since March 2001 Commission Regulation [13].

The objectives of the present research were to:

- Determine the level of Cd, Pb, Zn, Ni, Cu and chromium in *Panax Ginseng* samples purchased from Tehran and Beijing local herbal markets.
- Compare the heavy metal contents of *Panax Ginseng* extracted from the samples bought from local herbal markets in Tehran and Beijing and find the possible contaminating processes.

Materials and Methods

Sampling description

To examine the lead, cadmium, copper, chromium, nickel and zinc contents in *Panax Ginseng* samples, 100 samples were collected from Tehran herbal markets and 100 samples were purchased from 20 and 25 different local herbal markets in Beijing and Tehran respectively in 2012. A certain weight of each samples were digested and then analyzed by atomic absorption spectrophotometer

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

For heavy metal analyses, 5 grams of each sample was weighed and oven-dried at 60°C to a constant weight. Each oven-dried sample was put 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 in this experiment 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 HNO₃ 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 HNO₃ and NH₄I solution in a volumetric flask. The samples were analyzed by an Flame Emission Spectrophotometer Model AA-6200 (Shimadzu, Japan) using an air-acetylene flame for heavy metals-Pb, Cd, Cr, Ni, Zn and Cu. At least two standard solutions were used for each metal. All necessary precautions were taken to avoid any possible contamination of the sample as per the AOAC guidelines [14].

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 the Merck Co. 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.

Statistical analysis

Values were expressed as the mean (mg/kg) ± standard deviation (SD). The heavy metal contents differences form 2 original country markets were calculated by one way Anova by SPSS 17. Probability values of <0.05 were considered significant.

Results

The concentration levels of heavy metals in the samples were determined as mean ± SD of three replicates in each test and determined based on sample dry weight shows in Table 1 for Iranian and Chinese samples.

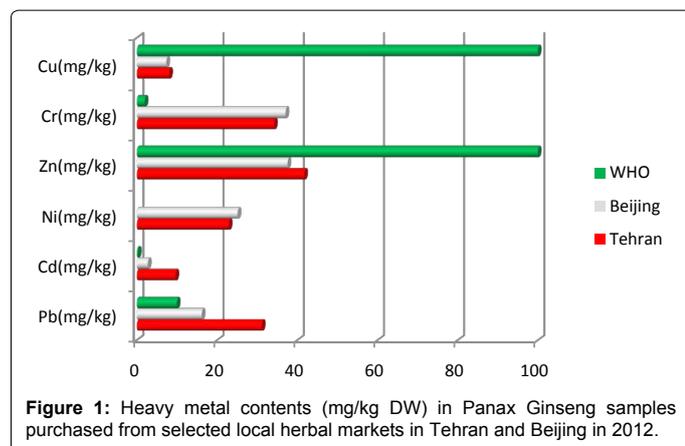
Results showed a significant increase in the lead, cadmium and chromium contents (p<0.05) in the samples bought from Tehran's markets compared to that of samples were purchased from Beijing markets. This discrepancy of concentration might be the result of transportation process. In Figure 1 comparing Heavy Metal contents in *ginseng* samples purchased from selected local herbal markets in Tehran and Beijing in 2012 can be seen.

Lead

Lead (Pb) is the main source of concern in terms of heavy metals contamination of *Panax Ginseng* samples obtained from herbal market

Metal	Location	Range (mg/kg DW ± SD)	Mean content (mg/kg DW ± SD)	WHO Permissible level
Pb	Tehran	29.91± 0.02 - 33.46 ± 0.04	31.21 ± 0.04	10
	Beijing	14.81 ± 0.05- 25.11 ± 0.03	16.21± 0.04	
Cd	Tehran	4.87 ± 0.05 - 11.37± 0.02	9.67 ± 0.03	0.3
	Beijing	1.28 ± 0.03-4.82± 0.03	2.77 ± 0.03	
Ni	Tehran	15.77 ± 0.07- 25.66± 0.03	22.96 ± 0.12	---
	Beijing	22.11 ± 0.04-31.71 ± 0.03	25.16 ± 0.03	
Zn	Tehran	36.19 ± 0.17- 44.22 ± 0.11	41.79 ± 0.15	100
	Beijing	33.17 ± 0.13-40.19 ± 0.16	37.12 ± 0.15	
Cr	Tehran	29.47 ± 0.04- 36.72 ± 0.07	34.26 ± 0.05	2
	Beijing	8.98 ± 0.04-8.98 ± 0.04	37.12 ± 0.15	
Cu	Tehran	5.44 ± 0.05- 11.27 ± 0.06	8.11 ± 0.06	100
	Beijing	40.19 ± 0.16-10.17 ± 0.05	7.39 ± 0.04	

Table 1: Average and minimum and maximum of metals (mg/kg DW ± SD) in *Panax Ginseng* samples purchased from Tehran and Beijing local herbal markets in 2012.



in Tehran and Beijing. Lead concentration of the Iranian samples ranged from 29.91 ± 0.02 mg/kg to 33.46 ± 0.04 mg/kg and lead concentration of the Chinese samples ranged from 14.81 ± 0.05 mg/kg to 25.11 ± 0.03 mg/kg. Quality control of 100% of 180 samples showed that both group of samples purchased from Tehran and Beijing markets contained Pb concentrations that exceeded the permissible limit set by WHO (WHO, 1989) [15]. 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 ATSDR [16].

Cadmium

Cadmium (Cd) is another major source of concern in terms of heavy metals contamination of *ginseng* samples. Cadmium concentration of the Iranian samples ranged from 4.87 ± 0.05 mg/kg to 11.37 ± 0.02 mg/kg and Cadmium concentration of Chinese samples ranged from 1.28 ± 0.03 mg/kg to 4.82 ± 0.03 mg/kg. Quality control of 100% of 180 samples showed that both group of samples showed that cadmium concentrations exceeded the permissible limit set by the European Commission Regulation [13]. WHO prescribed limit for Cd contents in medicinal plant at 0.3 mg/kg [15] and the maximum acceptable concentration for food stuff is around 1 ppm [17]. Cadmium intoxication can lead to kidney, bone and pulmonary damages [18].

Chromium

The mean concentration of Cr (Table 1) found in different Iranian samples was 31.21 mg/kg DW and Cr contents ranged from 8.98 ± 0.04 mg/kg to 15.36 ± 0.07 mg/kg in Chinese samples. Both group samples contained higher amounts of chromium than permissible limit of 0.5 ppm set by FDA [19]. However, WHO is yet to set limits for Cr contents in medicinal plants. However, Canadian authorities have set limits of Cr contents in raw medicinal plant material at 2 mg/kg [20]. It is notable that higher concentration of Cr than the critical level of 5.30 ppm could be a probable cause for yields reduction. The toxic impacts of Cr intake by human beings are known as skin rash, nose irritations, bleedings, upset stomach, kidney and liver damage, nasal itch and lungs cancer. Chromium deficiency is, moreover, characterized by disturbance in glucose lipids and protein metabolism [21].

Discussion

Concentration of essential and non-essential heavy metals in medicinal plants beyond permissible limit is a matter of great concern to public safety worldwide. The problem is rather serious in Iran

because medicinal plants are neither controlled nor properly regulated by quality assurance parameters. In order to find contaminating agents in *Panax Ginseng* (A herbal plant) and determining different steps of the pertinent contamination process, a comparison was carried out between the *Panax Ginseng* supplied in the Tehran (Iran) local markets and the crop available in local markets of Beijing (China) as the sole exporter of the herb to Iran.

A comparison between acceptable global standards and the level of Cr, Cd and Pb found in *Panax Ginseng* showed that the majority of the samples of medicinal plants (*Panax Ginseng* roots) obtained from Tehran markets contained higher levels of such heavy metals. Since the amount of heavy metals in the *Panax Ginseng* samples taken from Iranian markets is much higher than the corresponding content levels in the *Panax Ginseng* supplied in the Chinese markets, it may be concluded that the crop is contaminated in different stages of transportation and storage.

The results suggest that such organizations as the Health Ministry should assist in this regard by carrying out premarket reviews of all imported medicinal-herbal plants and herbal drugs before their launch. The products available in the markets should be analyzed regularly to ensure that they are free of hazardous ingredients and that the products actually contain the ingredients indicated on the labels. It is recommended considerable attention should be paid to alternative therapies, especially for the patients who may intake such herbal medicines for a long time. Therefore, certain group of patients such as elderly with cardiovascular problems and kidney deficiency who may intake these herbal products for long term should be extra cautions as they are more susceptible to toxicities.

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