

Environment Toxicology

Levels of Toxic Metals in Herbal Medicines used in the US

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Introduction

- Use of alternative medicine is increasing around the world
 As traditional medicine in Asian countries such as China, Taiwan, Korea, Japan
 Also becoming more popular in the USA and European countries
- Alternative Medicine
 Herbal drug, Acupuncture, Moxa, Yoga, Vitamins, Chiropractic, Massage, etc
- Herbal Medicines
 One form of complementary and alternative medicine
 Use crude materials (herbal, animals and mineral)
 Proprietary medicinal formula such as capsules, tablets, mixture pills, and boiled
 extraction (decoction)
- Herbal Medicine was found to be responsible for several causes of metal
 poisoning
- Few studies have been reported so far on the heavy metal content in herbal
 medicines consumed in the USA

Materials and Methods

- Sampled in big cities
 NY (w 29th ST) , LA (Olympic Blvd), Washington DC area (DC+Rockville, MD)
- The following herbal drugs were collected from participating herbalists

Table 1. Scientific name of Alternative medicines following classification and medical use part

Scientific name	Medical use part
1. <i>Adiantum species</i>	Herbal tea
2. <i>Asplenium species</i>	Herbal tea
3. <i>Cheilanthes species</i>	Herbal tea
4. <i>Polypodium species</i>	Herbal tea
5. <i>Thelypteris species</i>	Herbal tea
6. <i>Woodsia species</i>	Herbal tea
7. <i>Adiantum species</i>	Herbal tea
8. <i>Asplenium species</i>	Herbal tea
9. <i>Cheilanthes species</i>	Herbal tea
10. <i>Polypodium species</i>	Herbal tea
11. <i>Thelypteris species</i>	Herbal tea
12. <i>Woodsia species</i>	Herbal tea
13. <i>Adiantum species</i>	Herbal tea
14. <i>Asplenium species</i>	Herbal tea
15. <i>Cheilanthes species</i>	Herbal tea
16. <i>Polypodium species</i>	Herbal tea
17. <i>Thelypteris species</i>	Herbal tea
18. <i>Woodsia species</i>	Herbal tea
19. <i>Adiantum species</i>	Herbal tea
20. <i>Asplenium species</i>	Herbal tea
21. <i>Cheilanthes species</i>	Herbal tea
22. <i>Polypodium species</i>	Herbal tea
23. <i>Thelypteris species</i>	Herbal tea
24. <i>Woodsia species</i>	Herbal tea
25. <i>Adiantum species</i>	Herbal tea
26. <i>Asplenium species</i>	Herbal tea
27. <i>Cheilanthes species</i>	Herbal tea
28. <i>Polypodium species</i>	Herbal tea
29. <i>Thelypteris species</i>	Herbal tea
30. <i>Woodsia species</i>	Herbal tea

(P): Number of Alternative medicines using analysis

Materials

- Representative sampling of herbal drugs in big US cities
 Samples were collected on the same day (06/01/01) by 3 researchers
 Many Asians live in these areas
 One of the biggest markets offering many traditional medical clinics
- Confirmation by herbalist and traditional doctor
 Quality of specimen
 Medical use component (plant part)

Methods

- Divided 50g, respectively and enclosed in metal-free envelopes
- Sample preparation and analysis at the Center of Nature and Science,
 SangJi University, Korea
- EPA Standards analytic methods
- 9 metals: ICP-MS (Varian, Ultramas 700, USA 1998)
- Concentrations were compared with reference ranges for metals in herbal
 medicines promulgated by China and Singapore

Result

Table 2. Comparison of measurement values of metal concentration in herb decoctions between Korea Lab and Harvard University

Metals	Herbal decoction made in Korea*									
	Korea Lab measurement ¹⁾				Harvard University (Channing Lab) in USA ²⁾				correlation	P-value
	Mean	SD	Min	Max	Mean	SD	Min	Max		
Cr	0.21	0.28	0.00	0.77	0.29	0.07	0.21	0.46	0.38	0.49
Co	0.03	0.01	0.02	0.06	0.03	0.01	0.02	0.06	0.71	0.77
Ni	0.29	0.09	0.16	0.45	0.25	0.04	0.15	0.37	0.30	0.39
Cu	0.17	0.25	0.00	0.82	0.18	0.06	0.06	0.28	0.25	0.27
Cd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	1.00	1.00
Pb	0.36	1.38	0.00	4.45	0.33	0.58	0.02	2.33	0.59	0.67
Mn	5.20	2.51	2.13	9.67	5.22	3.16	1.72	13.02	0.20	0.32
Zn	1.57	1.04	0.21	3.86	1.34	0.31	0.67	2.00	0.21	0.38
As	0.04	0.02	0.02	0.07	0.07	0.02	0.03	0.11	0.43	0.56

* Originated from China and Korea. Samples made in Korea

¹⁾ Measured by Korea Lab (Sangji University, Center of Nature and Science)

²⁾ Measured by the Channing Lab of Harvard University in USA

Table 3. Geometric mean, SD, range, % exceeding China and Singapore Standard of heavy metal concentration for traditional herbal medicines* (for all samples N=170)

Metals	Unit: µg/g				
	Mean	SD	Min	Max	% ¹⁾
Cr	1.19	1.13	0.00	75.19	
Co	0.51	0.70	0.00	86.54	
Ni	1.15	0.97	0.00	68.72	
Cu	2.53	0.87	0.00	101.49	1.18
Cd	0.40	0.45	0.00	1.60	11.76
Pb	0.91	2.12	0.00	260.40	9.41
Mn	9.78	2.18	0.00	262.43	
Zn	7.54	1.21	0.00	75.19	
As	0.55	0.77	0.00	149.90	2.94

* Crude herbal drugs, not decoction (boiling) using in the US (New York, Los Angeles, Washington DC and Maryland)

¹⁾ Standards of metal in Chinese traditional medicine defined Pb<10µg/g, Cd<0.3µg/g in China, and Pb<20µg/g, Cu<150µg/g, As<5µg/g in Singapore. We applied their standards as Cd<0.3µg/g, Pb<10µg/g, Cu<150µg/g, As<5µg/g. However, there are no legal permit values in other metals and decoction (boiling) except these metals

*, exceeding China or Singapore Standard

Table 4. Geometric mean, SD, range, % exceeding China and Singapore Standard of heavy metal concentration for traditional herbal medicines by parts used* (for Herbal plants, Animals, Mineral samples)

Metal	Herbal Plants N=143				Animals N=11				Minerals N=18				Unit: µg/g
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	
Cd	1.08	1.00	0.12	6.37	1.08	1.79	0.37	11.11	2.58	1.75	0.37	25.18	
Cu	0.80	0.41	0.17	1.98	0.75	1.13	0.17	1.82	1.85	1.07	0.40	36.54	
Ni	0.97	0.77	0.17	4.13	2.20	0.70	0.17	0.76	3.40	1.46	0.37	18.72	
Cu	2.54	0.70	0.17	20.70	0.10	1.10	0.17	7.10	0.00	0.47	0.00	121.40	
Cd	0.54	0.41	0.17	1.10	11.90	0.70	0.41	0.37	0.00	0.00	0.17	0.00	
Pb	0.54	0.41	0.17	1.10	1.50	1.50	0.17	10.70	27.27	0.10	0.00	200.00	
Mn	11.00	1.94	0.17	476.43	2.01	1.94	0.17	204.76	1.87	2.01	0.17	107.77	
Zn	7.90	1.01	0.17	71.50	10.21	0.10	0.17	30.74	1.21	2.01	0.17	66.07	
Ag	0.00	0.00	0.17	1.70	0.00	0.17	0.17	0.17	0.00	0.00	0.17	100.00	

* Crude herbal drugs, not decoction (boiling) using in the US (New York, Los Angeles, Washington DC and Maryland)

1) Standards of metal in Chinese traditional medicine defined Pb<10µg/g, Cd<0.3µg/g in China, and Pb<20µg/g, Cu<150µg/g, As<5µg/g in Singapore. We applied their standards as Cd<0.3µg/g, Pb<10µg/g, Cu<150µg/g, As<5µg/g. However, there are no legal permit values in other metal and decoction(boiling) except these metals

*, exceeding China or Singapore Standard

Conclusion

• In herbal samples collected in NY, LA, Washington DC and Maryland, 0.0–12.50% for cadmium, 0.0–12.50% for copper, 0.0–50.00% for Arsenic, and 3.49–50.00% for lead exceeded the China and Singapore standards for heavy metals in traditional medicine remedies. Also that result differ by parts used(for herbal plant, animals, mineral samples)

• The geometric means of heavy metal concentration in these samples were 0.40(0.45)µg/g for cadmium, 2.53(0.87)µg/g for copper, and 0.91(2.12)µg/g for lead.

• The results of this pilot study suggest that the herbal medicine remedies may be an important source of toxic metal exposure in the US

• The standards for heavy metal concentrations in herbal materials used in alternative medicine may be urgently needed to prevent accidental poisoning among the consumers, especially Asian-Americans in big cities.