


[Home](#) > [Journal](#) > [Medicine & Healthcare](#) > [CM](#)
[Indexing](#) | [View Papers](#) | [Aims & Scope](#) | [Editorial Board](#) | [Guideline](#) | [Article Processing Charges](#)
[CM](#) > [Vol.3 No.4, December 2012](#)


## A Review of the Potential Issues of Pollution Caused by the Mineral Elements, Mercury, Lead and Arsenic, Its Possible Impacts on the Human Beings and the Suggested Solutions

PDF (Size: 319KB) PP. 167-178 DOI: 10.4236/cm.2012.34026

Author(s)

Yau Lam, Cho Wing Sze, Yao Tong, Tzi Bun Ng, Pang Chui Shaw, Yanbo Zhang

### ABSTRACT

**Objective:** This paper mainly discusses and summarises the potential issues of pollution caused by the Mineral elements, Mercury, Lead and Arsenic, its possible impacts on the human beings and the suggested solutions. **Methods:** This paper is prepared by reviewing the latest academic literatures. **Result:** First, this article discusses two aspects including the effects of Mercury, Lead and Arsenic on the Chinese herbal medicine and the potential issues of causing the environmental pollution. And then further study its toxicity effects and the side impacts on the human bodies in order to realize the actual circumstances people are encountering nowadays. This paper will also the corresponding its treatment method of reviews. Hope this will provide a valuable reference. **Conclusion:** These issues caused by the Mineral elements are prominent nowadays, thus the ongoing researches on the impacts of pollution and the possible solutions are regarded as highly valued in order to conserve the natural environment and meanwhile safeguard the well beings of people and the future offspring.

### KEYWORDS

Mineral Elements; Arsenic; Lead; Mercury

### Cite this paper

Y. Lam, C. Sze, Y. Tong, T. Ng, P. Shaw and Y. Zhang, "A Review of the Potential Issues of Pollution Caused by the Mineral Elements, Mercury, Lead and Arsenic, Its Possible Impacts on the Human Beings and the Suggested Solutions," *Chinese Medicine*, Vol. 3 No. 4, 2012, pp. 167-178. doi: 10.4236/cm.2012.34026.

### References

- [1] Y. W. Chiang, R. M. Santos, K. Ghyselbrecht, V. Cappuyns, J. A. Martens, R. Swennen, T. Van Gerven and B. Meesschaert, " Strategic Selection of an Optimal Sorbent Mixture for in-Situ Remediation of Heavy Metal Contaminated Sediments: Framework and Case Study," *Journal of Environmental Management*, Vol. 105, 2012, pp. 1-11.
- [2] A. Fischbein, " Occupational and Environmental Exposure to Lead," In: W. N. Rom, Ed., *Environmental and Occupational Medicine*, 3rd Edition, Lippincott-Raven, Philadelphia, 1998, pp. 973-996.
- [3] T. S. Bowers, B. D. Beck and H. S. Karam, " Assessing the Relationship between Environmental Lead Concentrations and Adult Blood Lead Levels," *Risk Analysis*, Vol. 14, No. 2, 1994, pp. 183-189.
- [4] A. A. Carbonell-Barrachina, M. A. Aarabi, R. D. Delaune, R. P. Gambrell and J. W. H. Patrick, " Arsenic in Wetland Vegetation: Availability, Phytotoxicity, Uptake and Effects on Plant Growth and Nutrition," *Science of the Total Environment*, Vol. 217, No. 3, 1998, pp. 189-199.
- [5] T. Pichler, R. Price, O. Lazareva and A. Dippold, " Determination of Arsenic Concentration and Distribution in the Floridan Aquifer System," *Journal of Geochemical Exploration*, Vol. 111, No. 3, 2011, pp. 84-96.
- [6] L. H. Zayas and P. O. Ozuah, " Mercury Use in Espiritismo: A Survey of Botanicas," *American Journal of Public Health*, Vol. 86, No. 1, 1996, pp. 111-112. doi:10.2105/AJPH.86.1.111
- [7] Association of Toxic Substances and Disease Registry (ATSDR), " Toxicological Profile for Mercury

[CM Subscription](#)
[Most popular papers in CM](#)
[About CM News](#)
[Frequently Asked Questions](#)
[Recommend to Peers](#)
[Recommend to Library](#)
[Contact Us](#)

Downloads:	51,088
Visits:	143,868

[Sponsors >>](#)

- [8] M. Amini, K. C. Abbaspour, M. Berg, L. Winkel, S. J. Hug, E. Hoehn, H. Yang and C. A. Johnson, " Statistical Modeling of Global Geogenic Arsenic Contamination in Groundwater," *Environmental Science & Technology*, Vol. 42, No. 10, 2008, pp. 3669-3675.
- [9] M. F. Ahmed, S. Ahuja, M. Alauddin, S. J. Hug, J. R. Lloyd, A. Pfaff, T. Pichler, C. Saltikov, M. Stute and A. van Geen, " Ensuring Safe Drinking Water in Bangladesh. *Science*," 2006. doi:10.1126/science.1133146
- [10] T. B. Chen, Y. M. Zheng, M. Lei, Z. C. Huang, H. T. Wu and H. Chen, " Assessment of Heavy Metal Pollution in Surface Soils of Urban Parks in Beijing, China," *Chemosphere*, Vol. 60, No. 4, 2005, pp. 542-551.
- [11] Z. P. Yang, W. X. Lu, Y. Q. Long and X. R. Liu, " Prediction and Precaution of Heavy Metal Pollution Trend in Urban Soils," *Urban Environment and Urban Ecology*, Vol. 23, No. 3, 2010, pp. 1-4.
- [12] P. Guo, Z. L. Xie, J. Li, C. L. Kang and J. H. Liu, " Relationships between Fractionations of Pb, Cd, Cu, Zn and Ni and Soil Properties in Urban Soils of Changchun City," *Chinese Geographical Science*, Vol. 15, No. 2, 2005, pp. 179-185.
- [13] T. Zhou, C. Z. Xi, T. G. Dai and D. Y. Huang, " Comprehensive Assessment of Urban Geological Environment in Changsha City," *Guangdong Trace Elements Science (in Chinese)*, Vol. 15, No. 6, 2008, pp. 32-38.
- [14] Z. P. Li, Y. C. Chen, X. C. Yang and S. Q. Wei, " Assessment of Potential Ecological Hazard of Heavy Metals in Urban Soils in Chongqing City," *Journal of Southwest Agricultural University Natural Science (in Chinese)*, Vol. 28, No. 2, 2006, pp. 227-230.
- [15] T. Chen, X. M. Liu, M. Z. Zhu, K. L. Zhao, J. J. Wu and J. M. Xu and P. Huang, " Identification of Trace Element Sources and Associated Risk Assessment in Vegetable Soils of the Urban-Rural Transitional Area of Hangzhou, China," *Environmental Pollution*, Vol. 151, No. 1, 2008, pp. 67-78.
- [16] K. L. Spencer, " Spatial Variability of Metals in the Inter-Tidal Sediments of the Medway Estuary, Kent, UK," *Marine Pollution Bulletin*, Vol. 44, No. 9, 2002, pp. 933-944.
- [17] M. J. Attrill and R. M. Thomes, " Heavy Metal Concentrations in Sediment from the Thames Estuary, UK," *Marine Pollution Bulletin* Vol. 30, No. 11, 1995, pp. 742-744.
- [18] J. Gonzalez-Perez, J. de Andres, L. Clemente, J. Martin and F. Gonzalez-Vila, " Organic Carbon and Environmental Quality of Riverine and Off-Shore Sediments from the Gulf of Cadiz, Spain," *Environmental Chemistry Letters*, Vol. 6, No. 1, 2008, pp. 41-46.
- [19] S. Fdez-Ortiz de Vallejuelo, G. Arana, A. de Diego and J. M. Madariaga, " Risk Assessment of Trace Elements in Sediments: The Case of the Estuary of the Nerbioilbaizabal River (Basque Country)," *Journal of Hazardous Materials*, Vol. 181, No. 1-3, 2010, pp. 565-573.
- [20] E. Prohic and G. Kniewald, " Heavy Metal Distribution in Recent Sediments of the Krka River Estuary—An Example of Sequential Extraction Analysis," *Marine Chemistry*, Vol. 22, No. , 1987, pp. 279-297.
- [21] M. Zhang, Z. He, P. Stoffella, D. Calvert, X. Yang and P. Sime, " Concentrations and Solubility of Heavy Metals in Muck Sediments from the St. Lucie Estuary, USA," *Environmental Geology*, Vol. 44, No. 1, 2003, pp. 1-7.
- [22] M. A. Rubio and F. Nombela, " Geochemistry of Major and Trace Elements in Sediments of the Ria de Vigo (NW Spain): An Assessment of Metal Pollution," *Marine Pollution Bulletin*, Vol. 40, No. 11, 2000, pp. 968-980.
- [23] D. Harland and A. Taylor Wither, " The Distribution of Mercury and Other Trace Metals in the Sediments of the Mersey Estuary over 25 Years 1974-1998," *Science of the Total Environment*, Vol. 253, No. 1-3, 2000, pp. 45-62.
- [24] J. Feng, H. Kirk, B. J. Cochran, D. J. Lwiza and B. Hirschberg, " Distribution of Heavy Metal and PCB Contaminants in the Sediments of an Urban Estuary: The Hudson River," *Marine Pollution Research*, Vol. 45, No. 1, 1998, pp. 69-88.
- [25] L. Carman, Z. Xiang-Dong, W. Gan and L. Onyx, " Trace Metal Distribution in Sediments of the Pearl River Estuary and the Surrounding Coastal Area, South China," *Environmental Pollution*, Vol. 147, No. 2, 2007, pp. 311-323.

- [26] S. Duquesne, L. C. Newton, L. Giusti, S. B. Marriott, H. J. Stark and D. J. Bird, " Evidence for Declining Levels of Heavy-Metals in the Severn Estuary and Bristol Channel UK and Their Spatial Distribution in Sediments," *Environmental Pollution*, Vol. 143, No. 2, 2006, pp. 187-196.
- [27] S. Franc. A. C. Vinagre, I. C. ador and H. N. Cabri, " Heavy Metal Concentrations in Sediment, Benthic Invertebrates and Fish in Three Salt Marsh Areas Subjected to Different Pollution Loads in the Tagus Estuary (Portugal)," *Marine Pollution Bulletin*, Vol. 50, No. 9, 2005, pp. 998-1003.
- [28] R. Prego and A. Cobelo-Garcia, " Twentieth Century Overview of Heavy Metals in the Galician Rias (NW Iberian Peninsula)," *Environmental Pollution*, Vol. 121, No. 3, 2003, pp. 425-452.
- [29] A. J. Marmolejo-Rodriguez, R. Prego, A. Meyer-Willerer, E. Shumilin and A. Cobelo-Garcia, " Total and Labile Metals in Surface Sediments of the Tropical River-Estuary System of Marabasco (Pacific Coast of Mexico): Influence of an Iron Mine," *Marine Pollution Bulletin*, Vol. 55, No. 10-12, 2007, pp. 459-468.
- [30] N. Fernandez, J. Bellas, J. Lorenzo and R. Beiras, " Complementary Approaches to Assess the Environmental Quality of Estuarine Sediments," *Water, Air, and Soil Pollution*, Vol. 189, No. 1-4, 2008, pp. 163-177.
- [31] M. Jayaprakash, M. P. Jonathan, S. Srinivasalu, S. Muthuraj, V. Ram-Mohan and N. Rajeshwara-Rao, " Acid-Leachable Trace Metals in Sediments from an Industrialized Region (Ennore Creek) of Chennai City, SE Coast of India: An Approach towards Regular Monitoring, Estuarine Coast," *Estuarine, Coastal and Shelf Science*, Vol. 76, No. 3, 2008, pp. 692-703. doi:10.1016/j.ecss.2007.07.035
- [32] G. Abraham and R. Parker, " Assessment of Heavy Metal Enrichment Factors and the Degree of Contamination in Marine Sediments from Tamaki Estuary, Auckland, New Zealand," *Environmental Monitoring and Assessment*, Vol. 136, No. 1-3, 2008, pp. 227-238. doi:10.1007/s10661-007-9678-2
- [33] F. Liu, W. Yan, W. Z. Wang, S. C. Gu and Z. Chen, " Pollution of Heavy Metals in the Pearl River Estuary and Its Assessment of Potential Ecological Risk," *Marine Environmental Science*, Vol. 21, No. 3, 2002, pp. 34-38.
- [34] X. Huang, X. Li, W. Yue, L. Huang and Y. Li, " Accumulation of Heavy Metals in the Sediments of Shenzhen Bay, South China," *Environmental Science (in Chinese with English Abstract)*, Vol. 24, No. 4, 2003, pp. 144-149.
- [35] X. D. Xu, Z. H. Lin and S. Q. Li, " The Studied of the Heavy Metal Pollution of Jiaozhou Bay," *Marine Sciences (in Chinese with English Abstract)*, Vol. 29, No. 1, 2005, pp. 48-53.
- [36] R. L. Yu, X. Yuan, Y. H. Zhao, G. R. Hu and X. L. Tu, " Heavy Metal Pollution in Intertidal Sediments from Quanzhou Bay, China," *Journal of Environmental Sciences*, Vol. 20, No. 6, 2008, pp. 664-669. doi:10.1016/S1001-0742(08)62110-5
- [37] L. P. Zhang, X. Ye, H. Feng, Y. H. Jing, O. Y. Tong, X. T. Yu, R. Y. Liang, C. T. Gao and W. Q. Chen, " Heavy Metal Contamination in Western Xiamen Bay Sediments and Its Vicinity, China," *Marine Pollution Bulletin*, Vol. 54, No. 7, 2007, pp. 974-982. doi:10.1016/j.marpolbul.2007.02.010
- [38] USEPA-Region II, USACE-New York District, USDOEBNL, " Fast Track Dredged Material Decontamination Demonstration for the Port of New York and New Jersey," 1999.
- [39] A. Filibeli and R. Yilmaz, " Dredged Material of Izmir Harbor: Its Behavior and Pollution Potential," *Water Science and Technology*, Vol. 32, No. 2, 1995, pp. 105-113. doi:10.1016/0273-1223(95)00575-8
- [40] M. H. Bothner, T. B. Buchholtz and F. T. Manheim, " Metal Concentrations in Surface Sediments of Boston Harbor— Changes with Time," *Marine Environmental Research*, Vol. 45, No. 2, 1998, pp. 127-155. doi:10.1016/S0141-1136(97)00027-5
- [41] CSBTS (China State Bureau of Quality and Technical Supervision), " Marine Sediment Quality," Standards Press of China, Beijing, 2002.
- [42] L. Zhu, J. Xu, F. Wang and B. Lee, " An Assessment of Selected Heavy Metal Contamination in the Surface Sediments from the South China Sea before 1998," *Journal of Geochemical Exploration*, Vol. 108, No. 1, 2011, pp. 1-14. doi:10.1016/j.gexplo.2010.08.002
- [43] G. D. Du, " White Paper on China's Drug Supervision," 2008. [http://news.xinhuanet.com/english/2008-07/18/content\\_8567067\\_4.htm](http://news.xinhuanet.com/english/2008-07/18/content_8567067_4.htm)

- [44] R. L. Nahin, P. M. Barnes, B. J. Stussman and B. Bloom, " Costs of Complementary and Alternative Medicine (CAM) and Frequency of Visits to CAM Practitioners: United States, 2007," National Health Statistic Reports, Vol. 30, No. 18, 2009, pp. 1-14.
- [45] D. M. Eisenberg, R. B. Davis, S. L. Ettner, S. Appel, S. Wilkey and M. van Rompay, " Trends in Alternative Medicine Use in the United States, 1990-1997—Results of a Follow-Up National Survey," The Journal of the American Medical Association, Vol. 280, No. 18, 1998, pp. 1569-1575. doi:10.1001/jama.280.18.1569
- [46] S. J. Eric, C. A. C. Shugeng, A. B. Littlefield, A. J. Craycroft, R. Scholten, T. Kaptchuk, Y. L. Fu, W. Q. Wang, Y. Liu , H. B. Chen, Z. Z. Zhao, J. Clardy, A. D. Woolf and D. M. Eisenberg, " Heavy Metal and Pesticide Content in Commonly Prescribed Individual Raw Chinese Herbal Medicines," Science of the Total Environment, Vol. 409, No. 20, 2011, pp. 4297-4305.
- [47] J. Liu, Y. F. Lu, Q. Wu, R. Goyer and M. P. Waalkes, " Mineral Arsenicals in Traditional Medicines: Orpiment, Realgar, and Arsenolite," Pharmacology, Vol. 326, No. 2, 2008, pp. 363-368. doi:10.1124/jpet.108.139543
- [48] J. Liu, J. Z. Shi, L. M. Yu, R. A. Goyer and M. P. Waalkes, " Mercury in Traditional Medicines: Is Cinnabar Toxicologically Similar to Common Mercurials?" Experimental Biology and Medicine, Vol. 233, No. 7, 2008, pp. 810-817. doi:10.3181/0712-MR-336
- [49] R. B. Saper, R. S. Phillips, A. Sehgal, N. Khouri, R. B. Davis and J. Paquin, " Lead, Mercury, and Arsenic in US-and Indian-Manufactured Ayurvedic Medicines Sold via the Internet," The Journal of the American Medical Association, Vol. 300, No. 8, 2008, pp. 915-923. 2008. doi:10.1001/jama.300.8.915
- [50] Y. F. Lu, Q. Wu, W. Miao, J. S. Shi and J. Liu, " Evaluation of Hepatotoxicity Potential of Cinnabar-Containing. An-Gong-Niu-Huang Wan, a Patent Traditional Chinese Medicine," Regulatory Toxicology and Pharmacology, Vol. 60, No. 2, 2011, pp. 206-211. doi:10.1016/j.yrtph.2011.03.007
- [51] A. Hamzah, C. W. Beh, S. B. Sarmani and J. Y. Liow, " Abugassa.Studies on Elemental Analysis of Chinese Traditional Herbs by Neutron Activation Technique and Their Mutagenic Effect. Journal of Radioanalytical and Nuclear Chemistry. J.Vol. 259, No. 3,499.503. 2004.
- [52] L.I. Qin, C. Chu, Y.Q. Wang, H.B. Chen, L.I. Ping, Z.Z. Zhao. Authentication of the 31 Species of Toxic and Potent Chinese Materia Medica by Microscopic Technique Assisted by ICP-MS Analysis, Part 4: Four Kinds of Toxic and Potent Mineral Arsenical CMMs," Microscopy Research and Technique Journal, Vol. 74, No. 1, 2011, pp. 1-8.
- [53] A. M. Evens, M. S. Tallman and R. B. Gartenhaus, " The Potential of Arsenic Trioxide in the Treatment of Malignant Disease: Past, Present, and Future," Leukemia Research, Vol. 28, No. 9, 2004, pp. 891-900. doi:10.1016/j.leukres.2004.01.011
- [54] Chinese Pharmacopoeia Commission, " Pharmacopoeia of the People' s Republic of China," People' s Medical Publishing House, Beijing, 2005.
- [55] M. Lin, Z. Y. Wang and D. S. Zhang, " Preparation of As<sub>2</sub>S<sub>3</sub> Nanoparticles and Their Therapeutic Effect on liver Cancer SMMC-7721 Cells," Journal of Southeast University (Natural Science Edition), Vol. 2, No. 36, 2006, pp. 298-302.
- [56] M. Lin and D. S. Zhang, " Effect of Orpiment Nanoparticles on Telomerase Activity in K562 Cell Line," Journal of the Medical Sciences, Vol. 11, No. 6, 2007, pp. 5-7.
- [57] K. Cooper, B. Noller, D. Connell, J. Yu, R. Sadler, H. Olszowy, G. Golding, U. Tinggi, M. R. Moore and S. Myers, " Public Health Risks from Heavy Metals and Metalloids Present in Traditional Chinese Medicines," Journal of Toxicology and Environmental Health A, Vol. 70, No. 19, 2007, pp. 1694-1699. doi:10.1080/15287390701434885
- [58] P. Westervelt, R. A. Brown, D. R. Adkins, H. Khoury, P. Curtin, D. Hurd, S. M. Luger, M. K. Ma, T. J. Ley and J. F. Dipersio, " Sudden Death among Patients with Acute Promyelocytic Leukemia Treated with Arsenic Trioxide," Blood, Vol. 98, No. 2, 2001, pp. 266-271. doi:10.1182/blood.V98.2.266
- [59] A. Liang, J. Wang, B. Xue, C. Li, T. Liu, Y. Zhao, C. Cao and Y. Yi, " Study on Hepatotoxicity and Nephrotoxicity of Cinnabar in Rats," Zhongguo Zhong Yao Za Zhi, Vol. 34, No. 3, 2009, pp. 312-328.
- [60] J. Liu, J. Z. Shi, L. M. Yu, A. R. Goyer and M. P. Waalkes, " Mercury in Traditional Medicines: Is Cinnabar Toxicologically Similar to Common Mercurials?" J Experimental Biology and Medicine, Vol. 233, No. 7, 2008, pp. 810-817.
- [61] C. D. Klaassen, " Heavy Metals and Heavy-Metal Antagonists," In: J. G. Hardman, L. E. Limbird and

A. G. Gilman, Eds., *The Pharmacological Basis of Therapeutics*, McGraw-Hill, New York, 2001, pp. 1851-1876.

- [62] Agency for Toxic Substances and Disease Registry, "Toxicological Profile for Mercury (Update)," Agency for Toxic Substances and Disease Registry, Atlanta, 1999.
- [63] J. F. Risher, H. E. Murray and G. R. Prince, "Organic Mercury Compounds: Human Exposure and Its Relevance to Public Health," *Toxicology and Industrial Health*, Vol. 18, No. 3, 2002, pp. 109-160. doi:10.1191/0748233702th138oa
- [64] G. Z. Lin, F. Wu, C. H. Yan, et al., "Childhood Lead Poisoning Associated with Traditional Chinese Medicine: A Case Report and the Subsequent Lead Source Inquiry," *Clinica Chimica Acta*, Vol. 413, No. 13-14, 2012, pp. 1156-1159. doi:10.1016/j.cca.2012.03.010
- [65] G. C. Fang, Y. L. Huang and J. H. Huang, "Study of Atmospheric Metallic Elements Pollution in Asia during 2000-2007," *Journal of Hazardous Materials*, Vol. 180, No. 1-3, 2010, pp. 115-121. doi:10.1016/j.jhazmat.2010.03.120
- [66] J. D. Marth, "A Unified Vision of the Building Blocks of Life," *Nature Cell Biology*, Vol. 10, No. 9, 2008, pp. 1015-1016. doi:10.1038/ncb0908-1015
- [67] B. Rowley and M. Monestier, "Mechanisms of Heavy Metal-Induced Autoimmunity," *Molecular Immunology*, Vol. 42, No. 7, 2005, pp. 833-838. doi:10.1016/j.molimm.2004.07.050
- [68] K. M. Pollard, P. Hultman and D. H. Kono, "Toxicology of Autoimmune Diseases," *Chemical Research in Toxicology*, Vol. 23, No. 3, 2010, pp. 455-466.
- [69] S. Bernard, A. Enayati, H. Roger, T. Binstock and L. Redwood, "The Role of Mercury in the Pathogenesis of Autism," *Molecular Psychiatry*, Vol. 7, No. 2, 2002, pp. S42-S43. doi:10.1038/sj.mp.4001177
- [70] J. M. Gorell, C. C. Johnson, B. A. Rybicki, E. L. Peterson, G. X. Kortsha, G. G. Brown and R. J. Richardson, "Occupational Exposures to Metals as Risk Factors for Parkinson's Disease," *Neurology*, Vol. 48, No. 3, 1997, pp. 650-658. doi:10.1212/WNL.48.3.650
- [71] J. Shu, J. A. Dearing, A. P. Morse, L. Yu and N. Yuan, "Determining the Sources of Atmospheric Particles in Shanghai, China, from Magnetic and Geochemical Properties," *Atmospheric Environment*, Vol. 35, No. 15, 2001, pp. 2615-2625. doi:10.1016/S1352-2310(00)00454-4
- [72] C.-F. Huang, S.-H. Liu and S. Y. Lin-Shiaub, "Neurotoxicological Effects of Cinnabar (a Chinese Mineral Medicine, HgS)," *Toxicology and Applied Pharmacology*, Vol. 224, No. 2, 2007, pp. 192-201. doi:10.1016/j.taap.2007.07.003
- [73] R. J. Huang, Z. X. Zhuang, Y. Tai, X. R. Wang and F. S. C. Lee, "Direct Analysis of Mercury in Traditional Chinese Medicines Using Thermolysis Coupled with On-Line Atomic Absorption Spectrometry," *Talanta*, Vol. 68, No. 3, 2006, pp. 728-734. doi:10.1016/j.talanta.2005.05.014
- [74] B. J. Alloway, "The General Monograph Herbal Drugs (1433)," *Pharmeuropa*, Vol. 20, No. 2, 2008, pp. 302-303.
- [75] Commission Regulation (EC) No. 629/2008 Amending Regulation (EC) No. 1881/2006 of 19 December 2006, "Setting Maximum Levels for Certain Contaminants in Foodstuffs." *Official Journal of the European Union*, Vol. 173, No. 51, 2008, pp. 6-9.
- [76] T. I. Lidsky and J. S. Schneider, "Neurotoxicity in Children: Basic Mechanisms and Clinical Correlates," *Brain*, Vol. 126, No. 1, 2003, pp. 5-19. doi:10.1093/brain/awg014
- [77] Agency for Toxic Substances and Disease Registry (ATSDR), "Toxicological Profile for Lead [Draft]," Public Health Service, US Department of Health and Human Services, Washington DC, 2005. [www.atsdr.cdc.gov/toxprofiles](http://www.atsdr.cdc.gov/toxprofiles)
- [78] US Centers for Disease Control and Prevention (CDC), "Third National Report on Human Exposure to Environmental Chemicals," Atlanta, 2005. [www.cdc.gov/exposurereport/3rd/default.htm](http://www.cdc.gov/exposurereport/3rd/default.htm)
- [79] A. Menke, P. Muntner, V. Batuman, E. K. Silbergeld and E. Guallar, "Blood Lead below 0.48 Micromol/l (10 microg/dl) and Mortality among US Adults," *Circulation*, Vol. 114, No. 13, 2006, pp. 1388-1394. doi:10.1161/CIRCULATIONAHA.106.628321
- [80] D. C. Bellinger, "Very Low Lead Exposures and Children's Neurodevelopment," *Current Opinion in Pediatrics*, Vol. 20, No. 2, 2008, pp. 172-177. doi:10.1097/MOP.0b013e3282f4f97b

- [81] C. D. Carrington and P. M. Bolger, " An Assessment of the Hazards of Lead in Food," *Regulatory Toxicology and Pharmacology*, Vol. 16, No. 3, 1992, pp. 265-272. doi:10.1016/0273-2300(92)90006-U
- [82] A. Gomaa, H. Hu, D. Bellinger, et al., " Maternal Bone Lead as an Independent Risk Factor for Fetal Neurotoxicity: A Prospective Study," *Pediatrics*, Vol. 110, Part 1, 2002, pp. 110-118. doi:10.1542/peds.110.1.110
- [83] S. DeMichele, " Nutrition of Lead," *Comparative Biochemistry and Physiology B-Biochemistry & Molecular Biology*, Vol. 78, No. 3, 1984, pp. 401-408.
- [84] M. J. Heard and A. C. Chamberlain, " Effect of Minerals and Food on Uptake of Lead from the Gastrointestinal Tract in Humans," *Human & Experimental Toxicology*, Vol. 1, No. 4, 1982, pp. 411-415. doi:10.1177/096032718200100407
- [85] K. M. Six and R. A. Goyer, " Experimental Enhancement of Lead Toxicity by Low Dietary Calcium," *Journal of Laboratory and Clinical Medicine*, Vol. 76, No. 6, 1970, pp. 933-942.
- [86] Y. Cheng, W. C. Willett, J. Schwartz, D. Sparrow, S. Weiss and H. Hu, " Relation of Nutrition to Bone Lead and Blood Lead Levels in Middle-Aged to Elderlymen. The Normative Aging Study," *American Journal of Epidemiology*, Vol. 147, No. 12, 1998, pp. 1162-1174. doi:10.1093/oxfordjournals.aje.a009415
- [87] T. W. Clarkson, " The Three Modern Faces of Mercury," *Environmental Health Perspectives*, Vol. 110, No. S1, 2002, pp. 11-23. doi:10.1289/ehp.02110s111
- [88] S. A. Counter and L. H. Buchanan, " Mercury Exposure in Children: A Review," *Toxicology and Applied Pharmacology*, Vol. 198, No. 2, 2004, pp. 209-230. doi:10.1016/j.taap.2003.11.032
- [89] I. Kosalec, J. Cvek and S. Tomic, " Contaminants of Medicinal Herbs and Herbal Products," *Archives of Industrial Hygiene and Toxicology*, Vol. 60, No. 4, 2009, pp. 485-501. doi:10.2478/10004-1254-60-2009-2005
- [90] US Centers for Disease Control and Prevention (CDC), " Third National Report on Human Exposure to Environmental Chemicals," 2005. [www.cdc.gov/exposurereport/3rd/default.htm](http://www.cdc.gov/exposurereport/3rd/default.htm)
- [91] Association of Toxic Substances and Disease Registry (ATSDR), " Toxicological Profile for Mercury (Update)," Department of Health and Human Services. Atlanta, 2006. <http://www.atsdr.cdc.gov/toxprofiles/tp46.html>
- [92] J. H. Roberts, " Metal Toxicity in Children, Training Manual on Pediatric Environmental Health: Putting It into Practice," 2005. <http://www.cehn.org/cehn/trainingmanual/manual-front.html>
- [93] W. H. Miller, H. M. Schipper, J. S. Lee, J. Singer and S. Waxman, " Mechanisms of Action of Arsenic Trioxide," *Cancer Research*, Vol. 62, No. 14, 2002, pp. 3893-3903.
- [94] World Health Organization (WHO), " WHO Guidelines for Assessing Quality of Herbal Medicines with Reference to Contaminants and Residue," WHO, Geneva, 2007.
- [95] B. Liu, X. Lv, D. Wang, Y. Xu, L. Zhang and Y. Li, " Adsorption Behavior of As(III) onto Chitosan Resin with As(III) as Template Ions," *Journal of Applied Polymer Science*, Vol. 125, No. 1, 2012, pp. 246-253. doi:10.1002/app.35528
- [96] M. Vahter, " Health Effects of Early Life Exposure to Arsenic," *Basic & Clinical Pharmacology & Toxicology*, 102, No. 2, 2008, pp. 204-211. doi:10.1111/j.1742-7843.2007.00168.x
- [97] E. J. Tokar, W. Qu and M. P. Waalkes, " Arsenic, Stem Cells, and the Developmental Basis of Adult Cancer," *Toxicological Sciences*, Vol. 120, No. S1, 2011, pp. S192-S203. doi:10.1093/toxsci/kfq342
- [98] M. P. Waalkes and J. Liu, " Early-Life Arsenic Exposure: Methylation Capacity and Beyond," *Environmental Health Perspectives*, Vol. 116, No. 3, 2008, pp. A104-A104. doi:10.1289/ehp.11276
- [99] K. L. Huyck, M. L. Kile, G. Mahiuddin, Q. Quamruzzaman, M. Rahman, et al., " Maternal Arsenic Exposure Associated with Low Birth Weight in Bangladesh," *Journal of Occupational and Environmental Medicine*, Vol. 49, No. 10, 2007, pp. 1097-1104. doi:10.1097/JOM.0b013e3181566ba0
- [100] R. Quansah and J. J. K. Jaakkola, " Paternal and Maternal Exposure to Welding Fumes and Metal Dusts or Fumes and Adverse Pregnancy Outcomes," *International Archives of Occupational and Environmental Health*, Vol. 82, No. 4, 2009, pp. 529-537. doi:10.1007/s00420-008-0349-6

- [101] J. Thompson and J. Bannigan, " Cadmium: Toxic Effects on the Reproductive System and the Embryo," *Reproductive Toxicology*, Vol. 25, No. 3, 2008, pp. 304-315. doi:10.1016/j.reprotox.2008.02.001
- [102] J. Liaw, G. Marshall, Y. Yuan, C. Ferreccio, C. Steinmaus, et al., " Increased Childhood Liver Cancer Mortality and Arsenic in Drinking Water in Northern Chile," *Cancer Epidemiology Biomarkers & Prevention*, Vol. 17, No. 8, 2008, pp. 1982-1987. doi:10.1158/1055-9965.EPI-07-2816
- [103] J. Liu and M. P. Waalkes, " Liver Is a Target of Arsenic Carcinogenesis," *Toxicological Sciences*, Vol. 105, No. 1, 2008, pp. 24-32. doi:10.1093/toxsci/kfn120
- [104] A. Anzblau and R. Lilis, " Acute Arsenic Intoxication from Environmental Arsenic Exposure," *Archives of Environmental Health: An International Journal*, Vol. 44, No. 6, 1989, pp. 385-390. doi:10.1080/00039896.1989.9935912
- [105] W. H. Mielke and S. Zahran, " The Urban Rise and Fall of Air Lead (Pb) and the Latent Surge and Retreat of Societal Violence," *Environment International*, Vol. 43, 2012, pp. 48-55. doi:10.1016/j.envint.2012.03.005
- [106] J. A. Menezes-Filho, G. F. de S. Viana and C. R. Paes, " Determinants of Lead Exposure in Children on the Outskirts of Salvador, Brazil," *Environmental Monitoring and Assessment*, Vol. 184, No. 4, 2012, pp. 2593-2603. doi:10.1007/s10661-011-2137-0
- [107] E. Nicholas, W. J. C. Pingitore Jr., A. M. A. Beata and M. J. J. Reynoso, " Urban Airborne Lead: X-Ray Absorption Spectroscopy Establishes Soil as Dominant Source," *The Smithsonian/NASA Astrophysics Data System*, Vol. 4, No. 4, 2009, p. e5019.
- [108] L. Luo, B. Chu, Y. Li, T. Xu, X. Wang, J. Yuan, J. Sun, Y. Liu, Y. Bo, X. Zhan, S. Wang and L. Tang, " Determination of Pb, As, Cd and Trace Elements in Polluted Soils near a Lead-Zinc Mine Using Polarized X-Ray Fluorescence Spectrometry and the Characteristics of the Elemental Distribution in the Area," *X-Ray Spectrometry*, Vol. 41, No. 3, 2012, pp. 133-143. doi:10.1002/xrs.2364
- [109] G. Z. Lin, F. Wu, C. H. Yan, K. Li and X. Y. Liu, " Childhood Lead Poisoning Associated with Traditional Chinese Medicine: A Case Report and the Subsequent Lead Source Inquiry," *Clinica Chimica Acta*, Vol. 413, No. 13-14, 2012, pp. 1156-1159. doi:10.1016/j.cca.2012.03.010
- [110] H. Bae, " Reducing Environmental Risks by Information Disclosure: Evidence in Residential Lead Paint Disclosure Rule," *Journal of Policy Analysis and Management*, Vol. 31, No. 2, 2012, pp. 404-431. doi:10.1002/pam.21600
- [111] F. Barbosa, C. D. Palmer, F. J. Krug, P. J. Parsons and J. Anal, " Determination of Total Mercury in Whole Blood by Flow Injection Cold Vapor Atomic Absorption Spectrometry with Room Temperature Digestion Using Tetramethylammonium Hydroxide," *Atomic Spectroscopy*, Vol. 19, No. 8, 2004, pp. 100-1005. doi:10.1039/b400315b
- [112] S. Q. Tao, S. F. Gong, L. Xu and J. C. Fanguy, " Mercury Atomic Absorption by Mercury Atoms in Water Observed with a Liquid Core Waveguide as a Long Path Absorption Cell," *Analyst*, Vol. 129, No. 4, 2004, pp. 342-346. doi:10.1039/b400426d
- [113] L. P. Yu and X. P. Yan, " Flow Injection On-Line Sorption Preconcentration Coupled with Cold Vapor Atomic Fluorescence Spectrometry and On-Line Oxidative Elution for the Determination of Trace Mercury in Water Samples," *Atomic Spectroscopy*, Vol. 25, No. 3, 2004, pp. 145-153.
- [114] G. Centineo, E. B. Gonzalez and A. Sanz-Medel, " Multi-Elemental Speciation Analysis of Organometallic Compounds of Mercury, Lead and Tin in Natural Water Samples by Headspace-Solid Phase Microextraction Followed by Gas Chromatography-Mass Spectrometry," *Journal of Chromatography A*, Vol. 1034, No. 1-2, 2004, pp. 191-197. doi:10.1016/j.chroma.2004.01.051
- [115] H. P. Chen, D. C. Paschal, D. T. Miller and J. D. C. Morrow, " Determination of Total and Inorganic Mercury in Whole Blood by On-Line Digestion with Flow Injection," *Atomic Spectroscopy*, Vol. 19, 1998, pp. 176-179.
- [116] P. J. Parsons, C. D. Palmer, K. L. Caldwell and R. L. Jones, " Determination of Total Mercury in Urine by Inductively Coupled Plasma Mass Spectrometry (ICP-MS)," *Royal Society of Chemistry, London*, 2005.
- [117] S. H. Rogers, N. Jeffery, S. Kieszak, P. Fritz, H. Spliethoff, D. Christopher, P. J. P. Parsons, E. Daniel, K. K. Caldwell, G. Eadon and C. Rubin, " Mercury Exposure in Young Children Living in New York City," *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, Vol. 85, No. 1, 2007, pp. 39-

- [118] W. B. Zhang, Z. F. Su, X. F. Chu and X. A. Yang, " Evaluation of a New Electrolytic Cold Vapor Generation System for Mercury Determination by AFS," *Talanta*, Vol. 80, No. 5, 2010, pp. 2106-2112. doi:10.1016/j.talanta.2009.11.016
- [119] X. R. Wang, Z. X. Zhuang, D. H. Sun, J. X. Hong, X. H. Wu, F. S. C. Lee, F. S. C. Lee, M. S. Yang and H. W. Leung, " Trace Metals in Traditional Chinese Medicine: A Preliminary Study Using ICP-MS for Metal Determination and as Speciation," *Atomic Spectroscopy*, Vol. 20, No. 3, 1999, p. 86.
- [120] S. Scholupov, S. Pogarev, V. Ryzhov, N. Mashyanov and A. Stroganov, " Zeeman Atomic Absorption Spectrometer RA-915+ for Direct Determination of Mercury in Air and Complex Matrix Samples," *Fuel Processing Technology*, Vol. 85, No. 6-7, 2004, pp. 473-485. doi:10.1016/j.fuproc.2003.11.003
- [121] R. J. Huang, Z. X. Zhuang, R. F. Huang, X. R. Wang and F. S. C. Lee, " Direct Analysis of Mercury in Traditional Chinese Medicines Using Thermolysis Coupled with On-Line Atomic Absorption Spectrometry," *Talanta*, Vol. 68, No. 3, 2006, pp. 728-734. doi:10.1016/j.talanta.2005.05.014
- [122] J. G. Tian, Y. Lu, J. G. Zhou, T. B. Gao, Q. T. Zheng and D. C. Chen, " The Powder X-Ray Diffraction Analysis of Mineral Drug Realgar with Its Associated Minerals," *Chinese Journal of Clinical Pharmacy*, No. 2, 1998, pp. 86-89.
- [123] H. Jiang, Y. H. Zhang, J. H. Ding, S. T. Shi, P. Xue, S. Gao, H. Z. Gong and G. F. Sun, " Determination of As(III) Content in Realgar by HPLCHG-AFS," *Chemical Research*, Vol. 19, No. , 2008, pp. 67-69.
- [124] G. Li, Y. K. Cheng, C. G. Huang, K. R. Li and Q. A. Wu, " Analysis on the Mineral Chinese Medicine Realgar," *Nanjing Shidan Xue Bao (Natural Science Edition)*, Vol. 31, No. , 2008, pp. 63-67.
- [125] L. W. Zhang, Y. H. Xie, S. L. Dong, Y. Y. Zhang and G. H. Su, " Researches on Arsenic and Its Appearance Analysis in Chinese Medicines (Review)," *Clinical Pharmacy*, Vol. 11, 2008, pp. 578-581.
- [126] S. Latva, M. Hurttta, S. Peraniemi and M. Ahlgren, " Separation of Arsenic Species in Aqueous Solutions and Optimization of Determination by Graphite Furnace Atomic Absorption Spectrometry," *Analytica Chimica Acta*, Vol. 418, No. 1, 2000, pp. 11-17. doi:10.1016/S0003-2670(00)00947-8
- [127] J. Dedina and D. L. Tsalev, " Hydride Generation Atomic Absorption Spectrometry," Wiley, Chichester, 1995.
- [128] P. Carrero, A. Malave, J. L. Burguera, M. Burguera and C. Rondon, " Determination of Various Arsenic Species by Flow Injection Hydride Generation Atomic Absorption Spectrometry: Investigation of the Effects of the Acid Concentration of Different Reaction Media on the Generation of Arsines," *Analytica Chimica Acta*, Vol. 438, No. 1-2, 2001, pp. 195-204. doi:10.1016/S0003-2670(01)00796-6
- [129] W. E. Gan, W. B. Zhang and X. Q. Lin, " Electrochemical Hydride Generation Atomic Fluorescence Spectrometry for the Simultaneous Determination of Arsenic and Antimony in Chinese Medicine Samples," *Analytica Chimica Acta*, Vol. 539, No. 1-2, 2005, pp. 335-340. doi:10.1016/j.aca.2005.03.050
- [130] H. M. Anawara, " Arsenic Speciation in Environmental Samples by Hydride Generation and Electrothermal Atomic Absorption Spectrometry," *Talanta*, Vol. 88, No. 28, 2012, pp. 30-42. doi:10.1016/j.talanta.2011.11.068
- [131] G. Pearson and G. Greenway, " A Highly Efficient Sample Introduction System for Interfacing Microfluidic Chips with ICP-MS," *Journal of Analytical Atomic Spectrometry*, Vol. 22, No. 6, 2007, pp. 657-662. doi:10.1039/b702624b
- [132] X. D. Tian, Z. X. Zhuang, B. Chen and X. R. Wang, " Movable Reduction Bed Hydride Generation System as an Interface for Capillary Zone Electrophoresis and Inductively Coupled Plasma Atomic Emission Spectrometry for Arsenic Speciation Analysis," *Analyst*, Vol. 123, No. 5, 1998, pp. 899-903. doi:10.1039/a707452b
- [133] Y. Liu and V. Lopez-Avila, " On-Line Microwave-Induced Helium Plasma Atomic Emission Detection for Capillary Zone Electrophoresis," *Journal of High Resolution Chromatography*, Vol. 16, No. 12, 1993, pp. 717-720. doi:10.1002/jhrc.1240161209
- [134] H. Matusiewicz and M. ?lachciński, " Method Development for Simultaneous Multielement Determination of Hydride Forming Elements (As, Bi, Ge, Sb, Se, Sn) and Hg by Microwave Induced Plasma-Optical Emission Spectrometry Using Integrated Continuous-Microflow Ultrasonic Nebulizer-Hydride Generator Sample Introduction System," *Microchemical Journal*, Vol. 95, No. 2, 2010, pp. 213-221. doi:10.1016/j.microc.2009.12.004



- [135] H. Matusiewicz and B. Golik, " Determination of Major and Trace Elements in Biological Materials by Microwave Induced Plasma Optical Emission Spectrometry (MIP-OES) Following Tetramethylammonium Hydroxide (TMAH) Solubilization," *Microchemical Journal*, Vol. 76, No. 1-2, 2004, pp. 23-29. doi:10.1016/j.microc.2003.10.007
- [136] K. Jankowski and A. Jackowska, " Spectroscopic Diagnostics for Evaluation of the Analytical Potential of Argon + Heliummicrowave-Induced Plasma with Solution Nebulization," *Journal of Analytical Atomic Spectrometry*, Vol. 22, No. 9, 2007, pp. 1076-1082. doi: 10.1039/b705288j
- [137] H. Matusiewicz and M. ?lachciński, " Development of a New Hybrid Technique for Inorganic Arsenic Speciation Analysis by Microchip Capillary Electrophoresis Coupled with Hydride Generation Microwave Induced Plasma Spec- trometry," *Microchemical Journal*, Vol. 102, 2012, pp. 61-67.
- [138] Q. J. Song, G. M. Greenway and T. McCreedy, " Interfacing a Microfluidic Electrophoresis Chip with Inductively Coupled Plasma Mass Spectrometry for Rapid Ele- mental Speciation," *Journal of Analytical Atomic Spectrometry*, Vol. 19, No. 7, 2004, pp. 883-887. doi:10.1039/b401657b
- [139] H. Matusiewicz and M. ?lachciński, " Interfacing a Microchip-Based Capillary Electrophoresis System with a Microwave Induced Plasma Spectrometry for Copper Speciation," *Central European Journal of Chemistry*, Vol. 9, No. 5, 2011, pp. 896-903. doi: 10.2478/s11532-011-0079-6
- [140] H. Matusiewicz and M. ?lachciński, " Interfacing a Microchip-Based Capillary Electrophoresis System with a Microwave Induced Plasma Spectrometry for Copper Speciation," *Central European Journal of Chemistry*, Vol. 9, No. 5, 2011, pp. 896-903.