



Determination of Mercury in Various Environmental Samples in 2012†

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This paper discusses the determination of mercury in different biological and environmental samples with various analytical techniques, such as atomic absorption spectroscopy, spectrophotometer, voltammeter, inductively coupled plasma techniques, Spectrofluorometer and HPLC/GC reported by the researchers worldwide during 2012.

Key Words: Mercury, Analytical methods, Environmental and biological samples.

INTRODUCTION

Mercury is the only metal in the periodic table exists in liquid state at standard temperature and pressure values. Mercury and its compounds mostly used in fluorescent lamps, thermometers and as electrodes. Due to its toxicity to humans in most cases it is replaced with others like Galinstan¹. Mercury, commonly exist in three oxidation states *i.e.*, 0 (metallic mercury), +1 (mercurous compounds) and +2 (mercuric/organomercury compounds). In high enough doses all forms of mercury are toxic². The toxicity of mercury depends on the solubility of their compounds, those which are soluble and volatile will become hazardous to human body and causes many adverse effects. The chronic mercury poisoning in children causes the disease called Acrodynia or pink disease³. One of the most tragic incidents regarding the mercury poisoning was observed in 1956 at Minamata bay of Japan and named the disease as Minamata disease, which induced the symptoms like numbness in the hands and feet, damage to hearing and speech. It may also cause paralysis, coma and death in extreme conditions⁴. The hazardous nature of mercury attracts so many researchers to found its concentration in various environmental matrices like water⁵⁻⁶ soil⁷ and air⁸ by using different analytical techniques.

So many authors reviewed the reported concentration of mercury and/or methylmercury in various environmental matrices with different analytical techniques. Leopold *et al.*⁹ reviewed for the determination and speciation of mercury, but it was limited only to natural waters. Pandey *et al.*,¹⁰ reviewed the measurement techniques for mercury in ambient air.

Recently, Cheng and Hu¹¹ reviewed the mercury in municipal solid waste in China. A lot of importance was given in recent years for the determination and speciation of mercury by the researchers in all over the world. This forces us to review the determination of mercury in various environmental matrices with different analytical techniques reported during 2012.

We reviewed the published research papers during 2012 in international journals regarding the determination of mercury with various analytical techniques. All the information of these reviewed papers is presented in Table-1. The literature survey reveals the need of accurate and precise methods for the determination of mercury in various environmental matrices. Most of the researchers determined the total mercury, but it is very important to determine the methylmercury due to its toxicity. This review predicts the need of speciation studies of mercury in future.

REFERENCES

1. P. Surmann and H. Zeyat, *Anal. Bioanal. Chem.*, **383**, 1009 (2005).
2. J.C. Clifton II, *Pediatric Clinics of North America*, **54**, 237 (2007).
3. G. Bjorklund, *J. Orthomol. Med.*, **10**, 145 (1995).
4. http://en.wikipedia.org/wiki/Minamata_disease
5. A.S. Yazdi, S. Banihashemi and Z. Eshaghi, *Chromatographia*, **71**, 1049 (2010).
6. D. Saniewska, M. Beldowska, J. Beldowski, M. Saniewski, J. Kwasniak and L. Falkowska, *J. Environ. Sci.*, **22**, 1144 (2010).
7. C. Gil, R. Miras, L.R. Perez and R. Boluda, *Chemosphere*, **78**, 409 (2010).
8. A.S. Brown, R.J.C. Brown, M.A. Dexter, W.T. Corns and P.B. Stockwell, *Anal. Methods*, **2**, 954 (2010).
9. K. Leopold, M. Foulkes and P. Worsfold, *Anal. Chim. Acta*, **663**, 127 (2010).
10. S.K. Pandey, K.H. Kim and R.J.C. Brown, *Trends Anal. Chem.*, **30**, 899 (2011).
11. H. Cheng and Y. Hu, *Environ. Sci. Technol.*, **46**, 593 (2012).

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TABLE-1
SUMMARY OF THE PUBLISHED PAPERS REGARDING DETERMINATION OF MERCURY IN 2012

S. No.	Analyte	Analytical Instrument used for the detection	Method	LOD	Analyzed Samples	Ref
1.	Hg	GFAAS	High frequency modulation polarization	0.4 µg L ⁻¹	Human blood	12
2.	Hg	CV-AAS	Automated on-line preconcentration	35 ng L ⁻¹	Tap water, River water and Coastal sea water	13
3.	Hg	CV-AAS	On-line sample treatment	0.68 µg L ⁻¹	Honey from Argentina	14
4.	Hg(II)	Spectrophotometer	CPE	1.65 µg L ⁻¹	Water samples	15
5.	Hg(II)	Square-wave anodic stripping voltammetry	Electro chemical determination	8.2 µg L ⁻¹	Water, fish tissue, human hair and food samples	16
6.	Hg	CV-AAS	Mid infrared quantitative determination	-	Soil samples	17
7.	Hg(II)	Potentiometer	Electro chemical determination	1.5 × 10 ⁻⁸ mol L ⁻¹	Water, Soil and CRM	18
8.	Hg vapour	CV-AAS	Flow injection	0.3 ng g ⁻¹	Road dust	19
9.	Hg(II)	Square-wave anodic stripping voltammetry	Extraction with electro-chemical determination	-	Indoor dust	20
10.	Hg	CV-ICP – MS	-	0.7 ng L ⁻¹	Humic rich natural waters	21
11.	Hg speciation	AAS	Thermo-desorption	0.02 mg kg ⁻¹	Soil and sediments	22
12.	Hg(II)	ELISA/CV-AFS	Immunization	-	Water samples, milk and green vegetable	23
13.	Hg(II)	Synchronous fluorescence spectroscopy	Fluorescence probe	4.2 × 10 ⁻⁹ mol L ⁻¹	Water samples	24
14.	Hg	Differential pulse anodic stripping voltammetry	Microextraction	0.06 n mol L ⁻¹	Fish and rice samples	25
15.	Hg	CV-AAS	Thermal decomposition	-	Red Aspen Bolete (Mushr –oom) and soil	26
16.	Hg	CV-AAS	Sample pyrolysis	-	<i>Russula ochro-leuca</i> (mushro- oms) and soil	27
17.	Hg	CV-AAS	-	0.5 nmol L ⁻¹	Gothenburg resident women serum	28
18.	Hg and organic Hg	CV-AAS	3051A US EPA	3.3 µg kg ⁻¹	Sediments	29
19.	Hg(II)	ICP-AES	SPE	23 ng L ⁻¹	Water, sediment, pig liver and lotus leaf	30
20.	Hg, MeHg	CV-AAS	Alkaline wet digestion	0.117 µg kg ⁻¹ (Me Hg), 0.133 µg kg ⁻¹ (Hg)	Muscle tissues of fish	31
21.	Hg(II)	Spectrophotometer	Localized surface Plasmon resonance	0.42 nmol L ⁻¹	Water samples	32
22.	Hg, MeHg	FAAS (Hg) GC-MS (MeHg)	-	-	Tuna cans	33
23.	Hg speciation	ICP-MS	Flow injection	0.77 µg L ⁻¹ [Hg(II)], 0.80 (Me Hg), 0.01 (total Hg)	Red wine	34
24.	Hg	AFS	Flow injection analysis	0.14 ng L ⁻¹	River waters	35
25.	Hg	Voltammetry	Electrochemical determination	0.2 µg L ⁻¹	Tap and river waters	36

GFAAS: Graphite furnace atomic absorption spectroscopy; CV-AAS: Cold-vapour atomic absorption spectroscopy; CPE: Cloud point; Extraction; ELISA: Enzyme-linked Immunosorbent assay; CRM: Certified reference materials; AFS: Atomic fluorescence spectroscopy; SPE: Solid phase extraction

12. N.B. Ivanenko, N.D. Solovyev, A.A. Ivanenko and A.A. Ganeev, *Achieves Environ. Contamination Toxicol.*, **63**, 299 (2012).
13. M. Puanngam, P.K. Dasgupta and F. Unob, *Talanta*, **99**, 1040 (2012).
14. M.A. Dominguez, M. Grunhut, M.F. Pistonesi and M.S. Di Nezio, *J. Agric. Food Chem.*, **60**, 4812 (2012).
15. H.I. Ulusoy, R. Gurkan and S. Ulusoy, *Talanta*, **88**, 516 (2012).
16. A. Afkhami, T. Madrakian, S.J. Sabounchei, M. Rezaei, S. Samiee and M. Pourshahbaz, *Sens. Actuators B*, **161**, 542 (2012).
17. S.R. Jean-Philippe, N. Labbe, J.A. Franklin and A. Johnson, *Proceed. Int. Acad. Ecol. Environ. Sci.*, **2**, 139 (2012).
18. F. Aboufazel, H.R.L. Zadeh Zhad, V. Amani, E. Najafi, O. Sadeghi and N. Tavassoli, *J. New Mater. Electrochem. Syst.*, **16**, 41 (2013).
19. A. Londonio, F. Fujiwara, R.J. Rebagliati, D. Gomez and P. Smichowski, *Microchem. J.*, **105**, 77 (2012).
20. E. Bernalte, C.M. Sanchez and E.P. Gil, *Talanta*, **97**, 187 (2012).
21. H. Pyhtila, P. Peramaki, J. Piispanen, M. Niemela, T. Suoranta, M. Starr, T. Nieminen, M. Kantola and L. Ukonmaanaho, *Microchem. J.*, **103**, 165 (2012).
22. A.T. Reis, J.P. Coelho, S.M. Rodrigues, R. Rocha, C.M. Davidson, A.C. Duarte and E. Pereira, *Talanta*, **99**, 363 (2012).
23. Y. Wang, H. Yang, M. Pschenitza, R. Niessner, Y. Li, D. Knopp and A. Deng, *Anal. Bioanal. Chem.*, **403**, 2519 (2012).
24. Y.Q. Wang, Y. Liu, X.W. He, W.Y. Li and Y.K. Zhang, *Talanta*, **99**, 69 (2012).
25. A.A. Ensafi, A.R. Allafchian, M. Saraji and B. Farajmand, *Talanta*, **99**, 335 (2012).
26. J. Falandysz, I. Kowalewska, I.C. Nnorom, M. Drewnowska and G. Jarynska, *J. Environ. Sci. Health Part A*, **47**, 1695 (2012).

27. M. Drewnowska, A. Sapor, G. Jarzynska, I.C. Nnorom, K.S. Sajwan and J. Falandysz, *J. Environ. Sci. Health Part A*, **47**, 1577 (2012).
28. I.A. Bergdahl, M. Ahlqvist, L. Barregard, C. Bjorkelund, A. Blomstrand, S. Skerfving, V. Sundh, M. Wennberg and L. Lissner, *Int. Achieves Occupat. Environ. Health*, **86**, 71 (2012).
29. R.L. Franklin, J.E. Bevilacqua and D.I.T. Favaro, *Quim. Nova*, **35**, 45 (2012).
30. Y. Jiang, H. Zhang, Q. He, Z. Hu and X. Chang, *Microchim. Acta*, **178**, 421 (2012).
31. A.Q. Shah, T.G. Kazi, J.A. Baig, H.I. Afridi and M.B. Arain, *Food Chem.*, **134**, 2345 (2012).
32. N. Bi, Y. Chen, H. Qi, X. Zheng, Y. Chen, X. Liao, H. Zhang and Y. Tian, *Sens. Actuators B*, **166-167**, 766 (2012).
33. J. Saramoli, N. Salamat, Sh. Najafpour, J. Hassan and T. Aliesfahani, *World Appl. Sci. J.*, **16**, 577 (2012).
34. V.L. Dressler, C.M.M. Santos, F.G. Antes, F.R.S. Bentlin, D. Pozebon and E.M.M. Flores, *Food Anal. Methods*, **5**, 505 (2012).
35. K. Leopold, A. Zierhut and J. Huber, *Anal. Bioanal. Chem.*, **403**, 2419 (2012).
36. D.M. Yerga, M.B.G. Garcia and A.C. Garcia, *Sens. Actuators B*, **165**, 143 (2012).