JOURNAL OF ENVIRONMENTAL SCIENCES XX (2016) XXX–XXX

Available online at www.sciencedirect.com

ScienceDirect

www.elsevier.com/locate/jes

JES JOURNAL OF ENVIRONMENTAL SCIENCES www.jesc.ac.cn

Q1 Methylated and thiolated arsenic species for environmental and health research — A review on synthesis and characterization☆

Q2 *William R. Cullen[1], Qingqing Liu[2], Xiufen Lu[2], Anthony McKnight-Whitford[2], Hanyong Peng[2], Aleksandra Popowich[3], Xiaowen Yan[2], Qi Zhang[2], Michael Fricke[1], Hongsui Sun[2], X. Chris Le[2,3,*]*

1. *Department of Chemistry, University of British Columbia, Vancouver, BC V6T 1Z1, Canada*
2. *Division of Analytical and Environmental Toxicology, Department of Laboratory Medicine and Pathology, University of Alberta, Edmonton, Alberta T6G 2G3, Canada*
3. *Department of Chemistry, University of Alberta, Edmonton, Alberta T6G 2G3, Canada*

ARTICLE INFO

Article history:
Received 17 November 2016
Revised 17 November 2016
Accepted 18 November 2016
Available online xxxx

Keywords:
Arsenic standards
Speciation analysis
Arsenic metabolites
Sulphur-containing arsenic species
Synthetic chemistry of arsenic
Pentavalent and trivalent methylarsenicals

ABSTRACT

Hundreds of millions of people around the world are exposed to elevated concentrations of inorganic and organic arsenic compounds, increasing the risk of a wide range of health effects. Studies of the environmental fate and human health effects of arsenic require authentic arsenic compounds. We summarize here the synthesis and characterization of more than a dozen methylated and thiolated arsenic compounds that are not commercially available. We discuss the methods of synthesis for the following 14 trivalent (III) and pentavalent (V) arsenic compounds: monomethylarsonous acid (MMA^{III}), dicysteinylmethyldithioarsenite (MMA^{III}(Cys)), monomethylarsonic acid (MMA^{V}), monomethylmonothioarsonic acid ($MMMTA^{V}$) or monothio-MMA^{V}, monomethyldithioarsonic acid ($MMDTA^{V}$) or dithio-MMA^{V}, monomethyltrithioarsonate ($MMTTA^{V}$) or trithio-MMA^{V}, dimethylarsinous acid (DMA^{III}), dimethylarsino-glutathione (DMA^{III}(SG)), dimethylarsinic acid (DMA^{V}), dimethylmonothioarsinic acid ($DMMTA^{V}$) or monothio-DMA^{V}, dimethyldithioarsinic acid ($DMDTA^{V}$) or dithio-DMA^{V}, trimethylarsine oxide ($TMAO^{V}$), arsenobetaine (AsB), and an arsenicin-A model compound. We have reviewed and compared the available methods, synthesized the arsenic compounds in our laboratories, and provided characterization information. On the basis of reaction yield, ease of synthesis and purification of product, safety considerations, and our experience, we recommend a method for the synthesis of each of these arsenic compounds.

☆ This manuscript is the result of the fruitful collaboration between the research groups of Dr. Cullen and Dr. Le. In Dr. Le's group, Liu, Lu, Peng, Popowich, Yan, and Zhang reviewed the pertinent literature and each wrote a major section. Dr. Sun, a former postdoctoral fellow with Dr. Cullen, synthesized most of the arsenic compounds described in this paper while he was a research associate in Dr. Le's group. Dr. Fricke, a former visiting student in Dr. Cullen's group, synthesized arsenobetaine. Dr. McKnight-Whitford, a former PhD student in Dr. Le's group, carried out mass spectrometry analyses of the arsenic compounds.

* *Corresponding author*. E-mail: xc.le@ualberta.ca (X. Chris Le).

http://dx.doi.org/10.1016/j.jes.2016.11.004
1001-0742/© 2016 The Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences. Published by Elsevier B.V.

Contents

Please cite this article as: Cullen, W.R., et al., Methylated and thiolated arsenic species for environmental and health research — A review on synthesis and characterization, J. Environ. Sci. (2016), http://dx.doi.org/10.1016/j.jes.2016.11.004