

FORMATION OF NITROGENOUS DISINFECTION BY-PRODUCTS (N-DBPS) IN RAW AND TREATED DRINKING WATER

D. Liew¹, K.L. Linge¹, C. Joll¹, A. Heitz¹, R. Trolio², L. Breckler², R. Henderson³ and J.W.A. Charrois¹

¹Curtin Water Quality Research Centre, Department of Chemistry, Curtin University, GPO Box U1987, Perth, Western Australia 6845, Australia

²Water Corporation of Western Australia, 629 Newcastle Street, Leederville, Perth, Western Australia 6007, Australia

³UNSW Water Research Centre, School Civil & Environmental Engineering, University of New South Wales, Sydney, NSW 2052 Australia

INTRODUCTION

Nitrogenous disinfection by-products (N-DBPs) can form in water sources with a high content of dissolved organic nitrogen. While most N-DBPs are not yet regulated in Australia, some N-DBPs have been shown to be more genotoxic and cytotoxic than the presently regulated DBPs. In this work, results from the most comprehensive survey of N-DBPs in drinking water in Australia will be presented. A review of literature helped to identify major groups of N-DBPs and *N*-nitrosamines, halonitriles, halonitromethanes and haloacetamides were selected for study in this survey because of their potential toxicity as well as evidence of occurrence in drinking waters and availability of analytical methods to detect these classes. Results from this survey will also be used to identify key drinking source waters for further investigation to predict and minimise N-DBPs formation.

METHODOLOGY

Analytical methods were developed for a suite of 28 N-DBPs, including *N*-nitrosamines, halonitriles, halonitromethanes, and haloacetamides, generally involving extraction (liquid-liquid, solid-phase or solid-phase-micro-extraction) followed by quantitation using gas-chromatography mass spectrometry. Raw and treated drinking waters from various drinking water systems across Western Australia were sampled. Drinking water treatment plants that utilise treatment polymers and/or ion-exchange resins, or treat raw waters with high dissolved organic carbon (DOC) and/or organic nitrogen, were included in the survey, as these factors may lead to N-DBP formation. While most of the drinking water systems were chlorinated, sampling was also undertaken in the Goldfields and Agricultural Water Supply (GAWS), which is the only chloraminated drinking water supply in Western Australia and includes the "Golden Pipeline", the longest distribution pipeline in Western Australia, which extends 560km east of Perth. The GAWS was sampled particularly intensively because it is known that the concentrations of some N-DBPs are higher in chloraminated systems than in chlorinated systems. Sampling was undertaken during both winter and summer to compare the effect of seasonal changes on N-DBP occurrence. Trends between observed N-DBP concentrations and water quality characteristics (e.g. DOC, total nitrogen, organic nitrogen, ammonia, nitrate, nitrite) were also investigated.

RESULTS

N-DBPs were typically only detected in treated drinking water at low $\mu\text{g/L}$ to ng/L concentrations, with no consistent detection in raw drinking water. There was also a general trend of increasing N-DBP

concentrations along distribution systems. Among the halonitriles, dihalogenated acetonitriles were the most frequently detected, while dihalogenated and trihalogenated amides were occasionally detected. Halonitromethanes were rarely detected except for dichloronitromethane. Some *N*-nitrosamines, especially *N*-nitrosodimethylamine (NDMA) were found at higher concentrations in the chloraminated GAWS than in chlorinated systems. Characterisation of dissolved organic matter enabled changes in organic matter to be monitored through distribution systems, particularly for the GAWS. The concentration of organic nitrogen decreased after disinfection. Formation of N-DBPs, however, could not account for all organic nitrogen remaining in the treated water.

CONCLUSION

The data collected provides the most comprehensive survey of N-DBPs in Australia to date. Comparison of the concentrations detected to currently regulated N-DBPs (e.g. NDMA, dibromoacetonitrile, dichloroacetonitrile and trichloroacetonitrile) indicates that N-DBP occurrence was at or below drinking water guidelines where they existed, suggesting low exposures for drinking water consumers. However, it should be noted that 24 of the 28 N-DBPs measured are not currently regulated, nor are toxicity data generally available for these compounds. Identification of frequently detected and unregulated N-DBPs provides an opportunity to prioritise these compounds, potentially leading to further investigation of their toxicity.