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Influence of Natural Organic Matter (NOM) Character on the Distribution of Chlorinated and Chloraminated Disinfection By-Products (DBPs) at Rand Water

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Certain disinfection by-products (DBPs) are likely human carcinogens or present mutagenic effects while many DBPs are unidentified. Considering the possibility of DBPs being harmful to human health and the fact that trihalomethanes (THMs) are the only regulated DBP in the South African National Standard (SANS:241) for drinking water, special interest in the precursors to these DBPs' formation is created. It is essential to understand the reactivity and character of the precursors responsible for the formation of DBPs in order to enhance precursor removal strategies during the treatment of drinking water.

In this study the character of NOM within surface water and the subsequent distribution of THMs formed in the drinking water from Rand Waters' full scale treatment plant were investigated. Molecular size distribution (MSD) of NOM within the surface water was determined by high performance size exclusion chromatography (HPSEC). Specific ultraviolet absorbance (SUVA) and UV_{254} measurements formed part of the NOM character study as they provide an indication of the aromaticity of organic matter. The four THMs; bromoform, chloroform, dibromochloromethane (DBCM) and bromodichloromethane (BDCM)were measured by gas chromatography. The sum of these four THMs was expressed as total trihalomethane (TTHM).

On average the chloroform constituted 76.2% of the total TTHM, BDCM 22.5% while DBCM and bromoform measured below the detection limit. THM speciation after chlorination and chloramination concentrations increased in the sequence bromoform $<$ DBCM $<$ BDCM $<$ chloroform. Results of the MSD showed a significant correlation between NOM of high molecular size (peak I) and TTHM formation specifically during the summer months (R^2= 0.971, $p < 0.05$). High molecular weight (HMW) NOM also related well to chloroform formation (R^2 = 0.963, $p < 0.05$) however, the formation of BDCM was not due to HWM fraction as indicated by weak regression coefficient. A positive correlation existed between SUVA and UV_{254} removal percentage (R^2 = 0.937, $p < 0.05$).

Seasonal variability in NOM character was evident in the source water in summer when high temperatures and rainfall occurred. The results displayed are an indication that aromatic NOM were the main precursor to TTHM formation, more prominently during summer.

Keywords: disinfection by-products, molecular size distribution, natural organic matter, UV_{254}