Purge-and-trap capillary gas chromatography with atomic emission detection for volatile halogenated organic compounds determination in waters and beverages

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Received 1 July 2003; received in revised form 9 February 2004; accepted 9 February 2004

Abstract

A method for the simultaneous determination of 10 volatile halogenated organic compounds (VHOCs), including four trihalomethanes (THMs), in waters and beverages was developed. The analytes were stripped from the aqueous sample by a flow of helium, preconcentrated in a capillary trap and thermally desorbed using a purge-and-trap (PT) system. This was followed by capillary gas chromatography with microwave-induced plasma atomic emission spectrometry (GC–AED). For element-specific detection, three wavelengths were monitored, corresponding to chlorine (479 nm), bromine (478 nm) and iodine (193 nm). Each chromatographic run took 21 min, including the purge time. After careful choice of the experimental conditions, the performance of the system was evaluated. Calibration curves were obtained by plotting peak area versus concentration and the correlation coefficients for linear calibration were at least 0.9987. Detection limits, calculated for 5 ml sample volume, ranged from 0.05 µg l⁻¹ for chloroform to 0.5 µg l⁻¹ for tetrachloromethane. The method was successfully applied to the quantitative analysis of water samples of different origin and also of several beer and juice samples. The tap water samples analyzed contain variable concentrations of the four trihalomethanes, ranging from 1.0 to 66.5 µg l⁻¹, depending of the compound. Whereas chloroform, bromodichloromethane and bromoform were found in some of the juice samples, only chloroform was detected in the beer samples. The method is reliable and can be used for routine monitoring in water and beverages.

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Keywords: Water analysis; Atomic emission detection; Beverages; Purge-and-trap methods; Volatile halogenated organic compounds; Trihalomethanes

1. Introduction

Volatile halogenated organic compounds (VHOCs) are an important chemical class of water pollutants. The water used as drinking water or in a wide variety of industrial applications is frequently disinfected with chlorine. However, the reaction of chlorine with the organic matter present in waters, particularly humic and fulvic acids or seaweed metabolic breakdown products [1], produces a number of volatile chlorination by-products, some of which are suspected of being carcinogenic. Furthermore, high bromide levels in reservoirs used as sources of drinking water contribute to the formation of brominated and mixed bromo/chloro-disinfection by-products (DBPs). The first category of DBP identified in water was the trihalomethanes (THMs), with dichlorobromomethane, dibromochloromethane, tribromomethane and trichloromethane being by far the most common.

VHOCs have potentially adverse effects on human health, and are incorporated in the body via the lungs or by food and drinking water via the gastrointestinal tract and, to some extent, via the skin [2]. The US Environmental Protection Agency (EPA) has published a list of contaminants and their maximum contaminant level (MCL) in drinking water [3], which includes eight of the VHOCs analyzed in this paper. The maximum contaminant level permitted in drinking water for tetrachloromethane, 1,2-dichloroethane and dichloromethane has been set at 5 and 80 µg l⁻¹ for total trihalomethanes (THMs). These tolerance levels are less restrictive under Spanish Legislation (R.D. 140/2003), which has established an MCL for THMs of 150 µg l⁻¹, which is to be reduced to 100 µg l⁻¹ [4] on 31 December 2008. Analytical methods for the determination of volatile organic compounds in water samples generally imply a...