Fast Screening Method for Bisphenol A in Environmental Water and in Food by Solid-Phase Microextraction (SPME)

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Introduction

Bisphenol A (2,2-bis(4-hydroxyphenyl)propane) (BPA) is used widely as a raw material for polycarbonate and epoxy resin. Recently, BPA in the environment, dentistry materials, tableware and in food, is suspected as having estrogenic activity. The extraction of BPA from environmental samples by authentic methods is complicated and heavy work. We propose here a simple and quick pretreatment procedure using solid-phase microextraction (SPME) for BPA.

Methods

Commercially available 85 μm film thickness polycrylate fibers housed in manual holders (Supelco) were used for the SPME extractions. 3.0 ml of sample water was mixed with 50 μl 10 ppm BPA-d₄ as internal standard, 20 μl concentrated hydrochloric acid to adjust pH to 2 or less, 0.4 g NaCl and a stirrer bar in a 5.0 ml vial. The SPME fiber was then exposed to the aqueous phase for 20 min with stirring at room temperature. After extraction, the fiber was immediately injected into the injection port of a QP-5000 (Shimadzu) GC-MS system at 70 eV of ionization energy equipped with a DB-5 column (30 m × 0.25 mm i.d. and with a film thickness of 1 μm) (J&W Scientific), and the fiber was exposed to He gas (40.5 cm/min at 120°C, 94.6 kPa, split ratio=100) for 20 min at 310°C to desorb BPA and BPA-d₄. BPA and BPA-d₄ were monitored in a selected ion monitoring (SIM) mode (m/z = 213, 228, 119, 224(BPA-d₄)). The injector was operated in the splitless mode and the split valve was opened after 3 min. The following column oven temperature program was applied: The column was held at 120°C for 10 min. It was increased at a heating rate of 30°C/min to 300°C, then held for 6 min, and then the column was post-treated at 315°C for 10 min.

Results and Discussion

From the preliminary experiment, we found that extraction of BPA was performed under conditions of pH<2.0, because extraction efficiency from water samples depended on pH, but not amount of NaCl. In addition, the detection limit and the identification limit of this SPME method was 2.0 and 0.1 ppb (or μg/l), respectively.

First of all, the SPME method for BPA was applied to measurement of samples from 4 rivers and 1 bay in Nagasaki Prefecture for the environmental water survey. Less than the identification limit (0.1 ppb) was found in samples from 3 rivers and 1 bay, although 1 river water sample showed 2.4 ppb. The results from this approach may suggest that SPME methods need to be improved for application to environmental water samples.

On the other hand, canned water solution samples showed detectable levels of BPA by the SPME method, for example, canned coffee (89.6 to 127.1 ppb), canned oolong tea (7.2–8.0 ppb) and canned soft drink (below 1.0 ppb). These results are at the same level as data from previous reports. The concentrations of BPA eluted with hot water (95°C, 30 min) from new and used tableware made of polycarbonate in elementary schools were 1.0 to 1.9 ppb and 1.8 to 7.9 ppb, respectively. In the case of polycarbonate nursing bottles, BPA concentrations eluted from new and used ones were below 1.0 to 3.5 ppb and below 1.0 to 6.5 ppb, respectively. Thus, higher levels of BPA were detected from used samples. This may be caused by increasing the surface area due to scratch marks. It was revealed that SPME was effective to analysis of food. This method is suitable for fast screening of BPA of numerous specimens.

References