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FLUORESCENCE CHARACTERISATION OF BISPHENOL A IN VARIOUS SOLVENTS AND DRINKING WATER

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Abstract

Environmental safety may be compromised by the presence of hazardous chemical compounds, such as bisphenol A (BPA), which is commonly used in the production of certain types of plastics. BPA is an emerging organic contaminant that could be found in many matrices, such as drinking water, due to anthropogenic activities. Within this study, we used fluorescence spectroscopy to analyse the photoluminescent characteristics of BPA in various solutions and drinking water. The emission spectra of BPA in various solvents are recorded from 280 nm to 380 nm, after excitation wavelength at 230 nm. These results imply that the fluorescence approach can be used for rapid detection and estimation of the level of BPA in water samples and, hence, for non-invasive monitoring of BPA in drinking water is an important concern for public health and environmental protection.

Keywords: bisphenol A, fluorescence, water safety, environmental protection.

INTRODUCTION

Bisphenol A (BPA), 2,2-bis(4-hydroxyphenyl) propane, is an organic compound composed of two phenol rings connected by a methyl bridge and two methyl functional groups attached to the bridge (Inset of Figure 1). BPA is commonly used as a raw material for the production of certain types of plastics such as epoxy resins, polycarbonate, etc. [1]. However, during long term decomposition of plastic materials, BPA can be leached from these plastics and contaminate food products, beverages, and other consumer products, leading to potential health risks [2]. As previously reported, BPA has genotoxicity, neurotoxicity, cytotoxicity, and reproductive toxicity, and is capable of causing endocrine-disrupting effects [3]. The potential risk to human health due to BPA exposure by drinking water is becoming an important topic of concern and a major environmental hazard. It was reported that the leaching of BPA from plastic wastes into the water is causing contamination of the water supply worldwide [4,5].

Sensitive and selective analytical techniques, such as gas chromatography coupled with mass spectrometry and high-performance liquid chromatography with a detector based on fluorescence, UV, or mass spectrometry, have been developed to determine the trace of BPA [3]. These techniques are time-consuming and use expensive equipment. So it is important to

develop rapid and non-expensive tools for screening of BPA in drinking water samples. BPA exhibits its fluorescence with emission at 300 nm and excitation maxima around 220 nm. However, BPA has low quantum efficiency in aqueous solutions. The fluorescence intensity of BPA increases significantly in other solvents such as ethanol, methanol, or acetonitrile [6]. Fluorescence spectroscopy is a non-invasive technique that can be used to detect the presence of BPA in various samples, including food, water, and human biological fluids [7]. To perform BPA fluorescence screening, a sample is first prepared by extracting BPA from the matrix using an appropriate solvent. This study aimed to optimize conditions appropriate for fluorescence detection of BPA in various solvents and drinking water. Furthermore, the detection threshold and the impact of the concentration of BPA on its emission spectra profile was examined.

MATERIALS AND METHODS

Chemicals and materials

Bisphenol A (2,2-Bis(4-hydroxyphenyl)propane, BPA, 97%) standard was purchased from Thermo Fisher Scientific Inc. (Waltham, MA, USA). Methanol (MeOH) (HPLC grade) was purchased from VWR International (Radnor, PA, USA). Ultrapure deionized water (Thermofisher Scientific, Bremen, Germany) was used to prepare samples solutions.

Sample preparation

The proper amounts of standard BPA were dissolved in methanol and deionised water, as well as in drinking water. Concentrations of BPA in methanol, deionised water, as well as spiked drinking water, are given in Table 1. The drinking water was collected from the laboratory tap. Generally, BPA has poor solubility in water, so solutions were stirred at room temperature for 60 min before analysis.

Fluorescence spectroscopy measurements

The fluorescence measurements were performed using an Fl3-221 P spectrofluorometer (JobinYvon, Horiba, France), which is equipped with a 450 W Xe lamp and a photomultiplier tube. The spectra of the samples were measured in the cuvette with 10 mm optical path and 1 ml volume, in the right-angle (RA) configuration at room temperature. The Integration time was set at 0.1 s. The fluorescence emission spectra of the proper amounts of standard BPA in metahnol, acetonitril, deionised water and drinking water were recorded in the range from 280 to 380 nm (increment 1 nm), after excitation at 230 nm. All recorded spectra were normalised.

RESULTS AND DISCUSSION

This study investigated the influence of variation in BPA concentration and usage of different solvents for this compound on the recorded fluorescence emission spectra. The normalised fluorescence emission spectra of different concentration of BPA in methanol are presented in Figure 1. After excitation at 230 nm, all the resulting spectra displayed the characteristic broad emission band from 280 to 380 nm [8]. We observed that increasing

concentrations of BPA in methanol lead to slightly red shifting in the position of their respective emission maxima, such as shown in Figure 1 and Table 1.

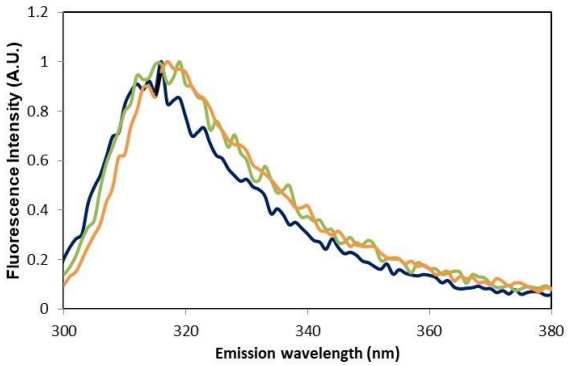

Figure 1 *Overlaid normalised fluorescence emission spectra of the different concentrattions of the BPA in metahnol (blue color coresponds to BPA concentration of 50 mg/L, green coresponds to 250 mg/L and orange to 350 mg/L)*

Table 1 *Position of the Emission maximua of BPA in spiked samples after excitation at 230 nm*

Matrix solvent (solutions)	Spiked level of BPA (mg L^{-1})	Emission maximum (nm)
Methanol	50	316
Methanol	250	318
Methanol	350	320
Methanol	450	322
Deionized water	0.15	316
Drinking water	0.12	317

Further, the fluorescence emission band (280–380 nm) of BPA in drinking water is presented in Figure 2. The observed weak fluorescent signal of BPA in drinking water with a maximum at 317 nm corresponds to the previously published results. It has been reported that fluorescence spectra of BPA are more susceptible to microenvironment changes and solvent polarity [8]. These results imply that BPA in analysed concentrations could be detected in real samples, such as drinking water using fluorescence spectroscopy as a highly sensitive method.

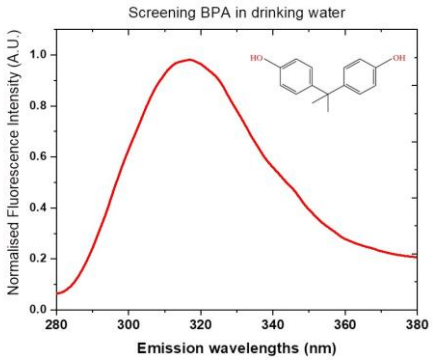

Figure 2 *Fluorescence Emission spectra of BPA in drinking water (0.12 mg/L), after excitation at 230 nm. Inset: Chemical structure of BPA.*

CONCLUSION

Our results indicate that the nature of solvents and concentrations of BPA affect fluorescence emission spectra of this compound, such as spectral width and position of the emission maxima. With increasing concentrations of BPA in methanol, the position of the emission maximum is red-shifted. Overall, the study shows that fluorescence spectroscopy could be used for the non-invasive screening of contaminants like BPA in drinking water. The upcoming research will focus on the fluorescence characterization of the other BPA-contaminated water samples from various environmental sources. Besides, developing a valuable non-invasive, rapid, and non-expensive fluorescence tool for monitoring BPA will increase environmental safety.

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