Determination of perfluorooctane sulfonate and perfluorooctanoic acid in food packaging using liquid chromatography coupled with tandem mass spectrometry

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ABSTRACT

This research aimed to monitor the amounts of PFOS and PFOA in food packaging and study the migration of PFOS and PFOA from food packaging, using a saliva simulant and pressurized liquid extraction (PLE) technique. Liquid chromatography coupled with tandem mass spectrometry (LC–MS/MS) was employed to determine residues of PFOS and PFOA by using a gradient reversed-phase method with ammonium acetate/acetonitrile buffer. A good linearity was established for PFOS and PFOA in a range of 0.05–10 μg L⁻¹, with R² ≥ 0.9998. Of the samples extracted by methanol, the highest concentration of PFOS was found in fast-food container samples, at a level of 92.48 ng dm⁻². For PFOA, the highest concentration in samples extracted by methanol was found in ice cream cup samples, at a level of 16.91 ng dm⁻². The amounts of PFOS and PFOA that migrated from food packaging samples through contact with saliva simulant were 4.80 and 4.55 ng dm⁻², respectively. Saliva simulants could leach PFOS and PFOA from the group of the thickest paper samples (≤ 1 dm² g⁻¹) at levels of 7.01 and 6.41 ng dm⁻², respectively, indicating that paper with greater thickness and less area might release larger quantities of coated/added PFOS or PFOA.

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1. Introduction

Perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) have been used in numerous industrial and commercial applications – including paper and textile treatments, production of fluoropolymers and cosmetics, and in insecticide formulations and firefighting foams – because of their unique properties as synthetic organic chemicals consisting of a fully fluorinated carbon chain and a sulfonate group or carboxylic group, respectively [1]. The presence of strong C–F bonds makes them chemically and thermally very stable, and resistant to hydrolysis, photolysis, microbial degradation or metabolism. However, PFOS and PFOA have been observed to persist in the environment, bioaccumulate in human and animal tissue, and biomagnify in food chains, and thus may have potentially significant adverse impacts on human health and the environment [1,2].

PFOS and PFOA belong to the wide group of perfluorinated compounds (PFCs). In the year 2000, growing concern about this class of chemicals resulted in the announcement by the largest producer, the 3M Company, to phase out the production of PFOS. Since then, a number of papers reporting environmental concentrations of PFOS and PFOA have been published. PFOS was recently included as a persistent organic pollutant (POP) in Annex B of the Stockholm Convention [3]. However, PFOA and the homologous chemicals of PFOS, which potentially may degrade to PFOS, are not regulated yet.

The concentrations of various PFCs have been determined in the human blood of individuals from a number of regions and countries around the world [4–6]. The half-lives of human serum elimination of PFOS and PFOA have been estimated at 5.4 and 3.8 years, respectively [7]. To mitigate any future risks associated with PFOS and PFOA, there is thus an urgent need for improved understanding of the pathways of human exposure.

Paper is the most widely used as packaging material. The surface of paper is treated to improve its properties, including physical strength, oil/grease resistance, and wettability. Food packaging products made of paper material usually contain coatings/additives with PFOS and PFOA for oil and water resistance [8,9]. Therefore, the analysis of PFOS and PFOA leached from the package into its contents is important for quality assurance and food safety. This research aims to monitor the amount of PFOS and PFOA in food packaging products made of paper material, and study the migration of PFOS and PFOA from food packaging using a saliva simulant and pressurized liquid extraction (PLE) technique.

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