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Universidad Zaragoza

Analysis of Migrant Compounds from Food Packaging: Application to Disposable Tableware and Risk Analysis

Carlos Estremera[1], Javier Blázquez-Martín[2,3], Cristina Nerín[1] and Celia Domeño[1,*]

[1]Grupo Universitario de Investigación Analítica (GUIA) Institute of Engineering (I3A) ,University of Zaragoza, Campus Río Ebro, Zaragoza, Spain

[2]University of La Rioja, Logroño, Spain

[3]National Centre for Packaging Technologies, Logroño, Spain

*Corresponding Author mail: cdomeno@unizar.es

Introduction

In modern society, disposable tableware is increasingly popular at events, especially children's parties, and convenient because it is easy to clean, inexpensive and lightweight. Additionally, there is a wide variety of colors, designs, and themes to decorate these events which imply the use of different additives, adhesives, inks and/or antioxidants that might migrate into food along with non-intentionally added substances (NIAS).

Each of these substances can be taken by consumers causing a risk to their health. (Nerin et al. 2013). To ensure safety, European legislation requires compliance with Regulation (EU) No 10/2011 on plastic materials intended for food contact and the UNE-EN 14338:2004 standard for paper and cardboard. This legislation mandates the identification of substances in these materials that could migrate into food and pose risks to consumers, through specific migration tests.

Advanced analytical techniques now enable effective and reliable identification of these compounds at low concentrations (Nerín et al. 2022) (Aznar, Domeño, Nerin 2023). Nevertheless, non-targetted analysis is a challenging issue and specific software to process all the generated data like MS-DIAL are highly valuable tools (Tsugawa et al. 2015).

Aims

The objective is to identify and quantify the migrants released from polypropylene (PP), polystyrene (PS) and cardboard (CB) disposable plates in order to assess the potential chemical risk to consumers when using these utensils.

At the same time, the process for non-directed analysis has been optimized using MS-DIAL software and a detailed guide has been developed. In addition, a literature search has been carried out to find out the use or origin of these compounds.

Figure 1: Plates made of polypropylene (PP), polystyrene (PS) and carboard (CB)

Metodología

Substance migration from nine types of disposable plates made from PP, PS and CB have been studied. Migration tests were performed in ethanol 10%, ethanol 95%, acetic acid 3% and Tenax © over 10 days at 40°C. Simulant extracts were analyzed using SPME-GC-MS and UPLC-QTOF-MS to identify and (semi)quantify volatile and non-volatile migrants, respectively. MS DIAL software was used to process all data.

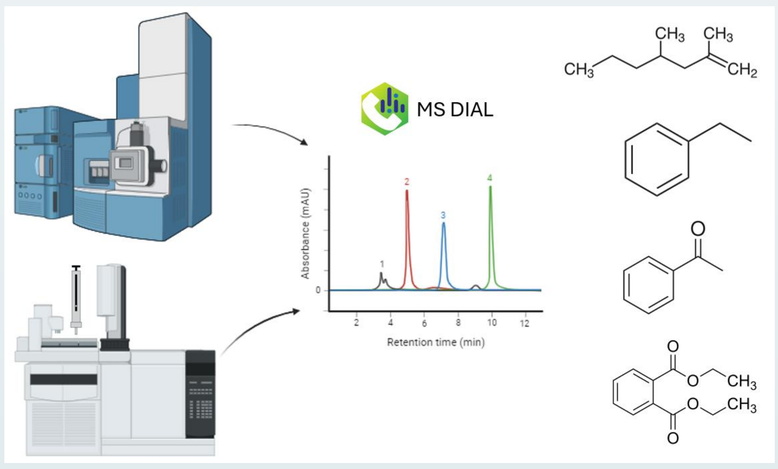

Figure 2: Processing workflow

Figure 3: MS-DIAL software identification features for data processing

Results

A total of 186 volatile and semi-volatile compounds were identified in all samples for all simulants. PP showed the highest number of migrants with 135 compounds which followed by PS with 87 and 69 for CD. In all materials, most of the compounds correspond to Non-Intentionally Added Substances (NIAS) of degradation or contamination.

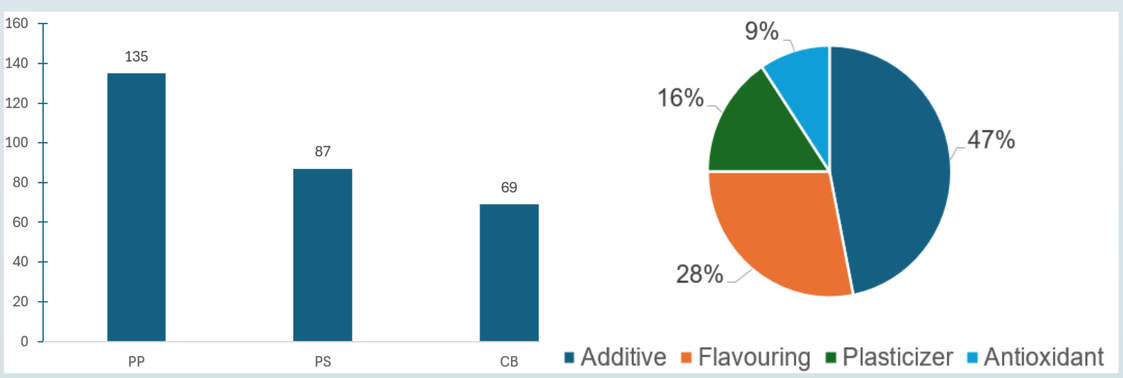

Figure 4: Total identified compounds per sample (Left), Distribution of PP compounds (Right)

Conclusiones

Intentionally Added Substances (IAS) were identified. Among them, plasticizers such as diethyl phathalete, dibutyl phthalate, diisobutyl phathalate and bis(2-ethylhexyl) phthalate were quantified. Diethyl phthalate which is not included in the EU 10/2011 Directive, showed levels higher than 10 ppb in some materials. Antioxidants like 3,5-di-tert-Butyl-4-hydroxybenzaldehyde and 2,4-Di-tert-butylphenol which are not included in the EU 10/2011 ware quantified with alarming values up to 1 ppm in same samples.

Regarding NIAS, styrene degradation products and styrene oligomers (Cyclobutane, 1,2-diphenyl- and Benzene, 1,1'-(1,3-propanediyl)bis-) were found in all simulants of all PS samples at safe concentration levels. MOAH markers from printing inks like 2,6-Diisopropylnaphthalene were found in most of the samples and in some of them at levels of 200 ppb. Moreover, flavouring agents such as .alpha.-Pinene, D-Limonene, hexadecanoic acid, ethyl ester and pentadecanoic acid were semiquantified.

The use of these dishes intended for long-term storage and/or heating between 70 and 100°C may present a risk to the consumer as they exceed the limits set by EU 10/2011.

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