GC(×GC)-TOFMS for targeted and untargeted analyses of paper analogues food contact materials

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Introduction:
Food contact materials (FCM) are often fossil-based, i.e., plastic (1). In 2021, the production of plastic was estimated at 390 million tons worldwide (2). However, there has been increasing concern about the behavior and fate of these materials when discarded into the environment (3). Consumer awareness is rising, and plastic FCM is pinpointed as a major environmental problem. Consequently, the FCM industry was under considerable public pressure to replace fossil-based plastics. Since July 3rd, 2021, certain single-use plastic articles have been banned in EU Member States (4). Various alternatives, considered more environmentally friendly, such as paper analogues FCM (e.g., paper and board, sugar cane pulp-based FCM), were developed and placed on the market. While these alternatives can be convenient, they must be safe for the consumers. Accordingly, this study aims to investigate potential migrations of substances from paper analogues FCMs using GC×GC-TOFMS. In addition, a comparative study of performance for the analysis of phthalates was performed between more conventional GC-MS/MS and alternative GC(×GC)-TOFMS.

Materials and Methods:
Fourteen FCMs made of paper and board (e.g., straw, pizza, hamburger boxes, cups…) and 4 sugar cane pulp FCMs (e.g., Hamburger boxes, cup…) were selected and migrated according to the time and temperature conditions set in the EURL guidelines (5). When article filling (e.g., cups) or immersion (e.g., straws) was possible, the intact article was migrated. If the article could not be filled or immersed (e.g., hamburger box), one dm^2 was cut and immersed in the food simulant (95% ethanol). Targeted (phthalates) and untargeted analyses were then performed on the simulant using an Agilent GC-MS/MS as well as the LECO Pegasus BTX GC(×GC)-TOFMS. Analytical standards of phthalates were purchased from Sigma Aldrich (Saint-Louis, USA) and solvents from Biosolve (Valkenswaard, The Netherlands).

Results:
The untargeted analyses identified numerous substances that could potentially migrate from paper analogue FCMs into food. These substances are being assessed for toxicological classification to determine whether they pose a threat to human health. Among the identified substances, phthalates, which are for some of them classified as reprotoxic and endocrine disruptors were found in a large number of samples. Therefore, phthalates were chosen to compare the quantification performance between a GC(×GC)-TOFMS vs GC-MS/MS. The concentrations of phthalates were found to be similar in both instruments tested, demonstrating the effectiveness of a GC(×GC)-TOFMS system originally designed for untargeted analyses. Furthermore, due to its high sensitivity, it can effectively compete with a system intended for targeted analyses.

Discussion and Conclusion:
Targeted analyses are powerful for quantifying and evaluating compliance of the samples in regard to legislation. However, it is crucial to couple this with untargeted analyses. Indeed, besides intentionally added substances (IAS), many unintentionally added substances (NIAS) can migrate into food and present a risk to human health. Therefore, having the possibility of carrying out both types of analyses on a same device (e.g. GC(×GC)-TOFMS) is a considerable gain for laboratories and should be further investigated to ensure consumer safety related to FCMs.

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