A review of sampling and analysis techniques for microplastics in food and the role of Py-GC/MS

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Abstract:

Microplastics (MPs) are increasingly recognized as emerging contaminants in food systems, raising concerns regarding human exposure and potential health risks. However, their accurate detection and quantification remain challenging due to the complex composition of food matrices, including lipids, proteins, and carbohydrates, which can interfere with analytical performance. This review critically evaluates current analytical workflows for MPs detection in food, including sampling, digestion, density separation, filtration, and instrumental analysis. Particular emphasis is placed on matrix-dependent pretreatment challenges and the need for tailored digestion strategies to ensure both efficient matrix removal and polymer preservation. Conventional spectroscopic techniques, such as FT-IR and Raman microscopy, are assessed for their strengths in particle-level identification and spatial resolution, as well as their limitations related to matrix interference, particle size detection thresholds, and fluorescence effects. In contrast, thermal analytical approaches—particularly Py-GC/MS—enable mass-based quantification and offer advantages for analyzing complex matrices, although they lack morphological information and may be affected by co-pyrolysis artifacts. The review further highlights key considerations in method validation, including calibration strategies, recovery assessment, and interlaboratory variability, underscoring the need for standardized protocols. A tiered analytical strategy integrating thermal and spectroscopic techniques is proposed to improve analytical robustness. Future work should focus on harmonization, automation, and integration with toxicological assessment frameworks to enhance the reliability of MPs analysis in food systems.

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