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ASSESSMENT OF OVERALL MIGRATION AND METAL CONTRIBUTION FROM PLASTIC FOOD CONTACT MATERIAL

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Introduction

Plastic food contact materials are complex systems that may release chemical substances into food during processing, storage and use. These substances include intentionally added substances (IAS), such as monomers, additives, catalysts and processing aids, as well as non-intentionally added substances (NIAS). NIAS may originate from impurities in raw materials, secondary chemical reactions, manufacturing operations or contamination occurring throughout the material life cycle. Due to their diverse origins and chemical complexity, NIAS represent a major challenge in the safety assessment of food contact materials.

Overall migration testing is an important regulatory tool used to evaluate the general inertness of plastic food contact materials intro food simulant under standardized conditions. However, this parameter does not provide information regarding the identity, origin or toxicological relevance of the migrated substances and cannot differentiate between IAS, NIAS and other non-volatile constituents. Lead, cadmium, copper and manganese may occur in plastic food contact materials as impurities, contaminants or constituents of pigments and other components. Their determination may provide additional information on the composition of the migrated residue.

The objective of this study was to evaluate overall migration results for plastic food contact materials during official control activities conducted by National Institute of Public Health (NIPH), between 2020- 2025 and to estimate the contribution of lead, cadmium, copper and manganese to the overall migration values. The study also aimed to highlight the limitations of overall migration testing in the chemical characterization of migrated substances and its relevance within a broader IAS and NIAS assessment strategy.

Materials and methods

A retrospective analysis was conducted using internal analytical records form NIPH control activities. The dataset comprised 485 plastic food contact materials and articles monitored between 2020 and 2025. A total of 1097 overall migration determinations were performed because individual samples could require testing with more than one food simulant or under different contact conditions, depending on their intended use. Overall migration testing was carried out in accordance with the provisions of Commission Regulation (EU) no 10/2011 on plastic materials and articles intended to come into contact with food and the EN 1186 series of standards

[1]. Food simulants and testing conditions were selected according to the intended food contact application and the foreseeable conditions of use of each material. The samples were tested under conditions representative of contact with aqueous, acidic, alcoholic and fatty foods. The most frequently used food simulants were 3% acetic acid, 10% ethanol and isooctane.

For a subset of samples, specific migration determinations were additionally performed for lead, cadmium, copper and manganese in 3% acetic acid by atomic absorption spectrometry. Where paired and comparable results were available, their cumulative elemental concentrations were compared with the corresponding overall migration values obtained using the same food simulant. Their percentage contribution was calculated as the ratio between the cumulative elemental concentration and the corresponding overall migration value, using results expressed on a compatible basis.

Results and conclusions

Of the 1097 overall migration determinations, approximately 99.4% complied with the applicable overall migration limit, indicating a high level of conformity among the plastic food contact materials included in the monitoring program. Nevertheless, the occurrence of a limited number of non-compliant results confirms the importance of continuing official control and applying testing conditions appropriate to the intended use of each material.

Polyethylene and polypropylene were the predominant polymer categories, accounting for 183 and 164 samples, respectively. Other relevant categories included polystyrene (34 samples), polyethylene terephthalate (33 samples) and multilayer materials (25 samples). Approximately 480 determinations were carried out using 3% acetic acid, approximately 430 using 10% ethanol and 177 using isooctane.

For samples with comparable overall and specific migration results, the cumulative elemental concentrations of lead, cadmium, copper and manganese represented less than 1% of the corresponding overall values. Therefore, the measured elements explained only a small fraction of the total non-volatile residue determined by overall migration testing. The remaining fraction cannot be considered exclusively NIAS, as it may also include IAS, oligomers, degradation products and other unidentified organic and inorganic constituents.

Overall migration remains an essential compliance parameter but cannot provide complete chemical characterization of the migrated residue. Therefore, it should be complemented by specific migration testing and targeted, suspect screening and non-targeted methods to support the identification of IAS and NIAS and improve the safety assessment of plastic food contact material.

References

[1] EN 1186. Materials and articles intended to come into contact with foodstuffs – Plastics.