ASSESSMENT OF MIGRATION OF SUBSTANCES FROM BIODEGRADABLE PACKAGING MATERIALS INTO FOOD PRODUCTS USING ADVANCED ANALYTICAL TECHNIQUES: CHALLENGES AND POTENTIAL FOR SUSTAINABLE DEVELOPMENT

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Abstract

Contemporary requirements of sustainable development impose an increasing need to switch from conventional plastic packaging materials to sustainable, biodegradable and compostable alternatives with the aim of reducing the ecological footprint of the food industry, which is under pressure to reduce plastic waste. Biodegradable food packaging is gaining importance due to environmental and regulatory requirements, but the use of biodegradable materials raises new questions about food safety. Namely, intentionally added substances (IAS) - such as monomers, stabilizers or bioactive additives - and unintentionally present substances (NIAS) - such as degradation products or pollutants - can migrate from packaging to food [1,2]. These substances can change the organoleptic properties of food or pose a health risk, so the identification and quantification of IAS and NIAS is crucial for evaluating the safety of biodegradable packaging [3,4]. Modern analytical techniques, especially GC-MS/MS and LC-QToF, enable the detection of even the smallest traces of migrants and represent the basis for the development of regulatory guidelines and new materials [2]. Gas Chromatography–Tandem Mass Spectrometry (GC-MS/MS) is used for volatile and semi-volatile migrants of low molecular mass (<800 Da) originating from biodegradable packaging. The application of polar and non-polar columns in combination with "soft" ionization techniques ensures reliable identification and quantification of IAS and NIAS in food [2,5]. This technique is suitable for screening unknown substances because it can generate molecular ions and characteristic fragments necessary for structural identification. In contrast, Liquid Chromatography–Quadrupole Time-of-Flight Mass Spectrometry (LC-QtToF) is the method of choice for nonvolatile migrants. LC-QToF enables identification even when no standards are available. By combining GC-MS/MS for volatiles and LC-QToF for non-volatile migrants, a comprehensive profile of IAS and NIAS from biodegradable packaging is achieved [6]. Previous research has shown that biodegradable polymers such as PLA and PHA can release a range of low molecular weight compounds, including additives, monomer residues and degradation products [7, 8]. Using GC-MS/MS and LC-QToF techniques, migrants such as phthalates, alcohols and esters, which may have a potential impact on food safety, were identified [9,10]. It was also found that the composition and structure of biodegradable packaging materials, as well as storage conditions, significantly affect the migration profile [11, 12]. Understanding the risks and benefits of using "green" packaging materials used for packaging food products is extremely important, in order to ensure not only food safety, but also environmental protection in accordance with the principles of sustainable development.

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