CUTTING-EDGE ANALYTICAL TECHNIQUES FOR NANOPARTICLES IN FOOD

Stefan Weigel[1*], Ruud Peters[2]
[1] RIKILT, Wageningen, The Netherlands
[2] RIKILT, Wageningen, The Netherlands
*Corresponding author - E-mail: stefan.weigel@wur.nl , Phone: ++31 317 485518

Nanotechnology applications for the food sector are intensively investigated and developed at the moment. A number of nanomaterials are already in use as food additives or in food contact materials. Furthermore, approved (bulk) food additives may have a size distribution which extends down to the sub 100 nm range, e.g. fumed silica (E551). At the same time, limited knowledge is available on the potential impact of engineered nanoparticles (ENP) on consumers' health. A prerequisite for toxicological, toxicokinetic, migration and exposure assessment studies is the availability of analytical tools for the detection and characterisation of ENP in complex matrices such as food. Given the huge diversity of ENP for potential use in the food and feed sector in terms of chemical composition, size, size distribution, surface activity/modifications etc. and possible interactions with food matrix components (e.g. proteins) it is a challenging task to develop tailored solutions. While there are a number of established techniques to characterise (inorganic) ENP in their pure state it is crucial for food to develop sample preparation techniques that yield artefact-free samples for imaging techniques or separate the particles from the matrix for subsequent application of suited detection techniques, e.g. mass spectrometry. In the case of imaging techniques electron microscopy in its different forms (e.g. SEM, TEM) seems most promising, especially when coupled to spectroscopic methods such as EDX. Screening approaches for specific applications include the use of biosensors with ENP-specific recognition elements and ELISAs for certain organic ENP. A combination of instrumental separation techniques with specific detectors is often unavoidable for the reliable characterisation and quantification of ENP in the food matrix. Hydrodynamic chromatography (HDC) is a robust flow technique for the separation of ENP from larger particles and matrix components. It has successfully been applied to the measurement of silica NP in food commodities. Field flow fractionation (FFF) offers a higher resolution as compared to HDC and has been used for the separation of different inorganic ENP (e.g. Ag, SiO_2, TiO_2). Differential mobility analysis (DMA) can also be utilised for the analysis of liquid sample extracts when a tailored electrospray ionisation is applied. Detectors that can be combined on- or off-line with these separation techniques include light scattering (SLS, DLS, NTA), UV-DAD and mass spectrometry. In particular ICP-MS is the method of choice for inorganic ENP. Single particle ICP-MS is an interesting approach for the rapid screening for ENP in complex matrices after minimal sample preparation. The selection of an appropriate detector for organic ENP largely depends on the size and composition of the target analyte. Conventional HPLC-MS can be used for fullerenes, while in the case of complex protein based encapsulates MALDI-ToF-MS can be an option.

Keywords: nanoparticles, electron microscopy, separation (FFF, HDC, DMA), mass spectrometry (ICP-MS, MALDI-ToF), screening (biosensor, ELISA)

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