

## Identification and characterization of inorganic food additives and pearlescent pigments in sprays for food decoration by STEM-EDX

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Food colorants are applied in commercial products and domestic cooking to enhance the appearance of food. To obtain specific hues, inorganic food additives containing (nano)particles are mixed in varying concentrations, and pearlescent pigments consisting of mica platelets coated with a layer of titanium dioxide and/or iron oxide particles, are applied to provide glitter effects<sup>1</sup>. For assessing potential risks of multi-constituent substances and mixtures, characterisation of the fraction of small particles, including the particle size distribution, is needed for each single constituent or each component in the mixture<sup>2</sup>. This is challenging for control laboratories and only limited guidance is currently available<sup>3</sup>.

This study developed electron microscopy-based methods to identify and characterize the particles of individual components in eight commercially available food-decoration sprays of different colours, containing mixtures of food additives and pearlescent pigments. No dispersion protocols or purifications steps were applied so as to faithfully reproduce the properties of the particles consumers are exposed to. Samples were prepared by spraying 5 mL in a glass vial and coated on EM-grids using the grid-on-drop method. Scanning transmission electron microscopy (STEM) combined with energy dispersive X-ray spectroscopy (EDX) allowed identifying individual components, including potassium aluminium silicate-based pearlescent pigments, vegetable carbon, rutile titanium dioxide, iron oxide and aluminium containing (nano)particles by their elemental composition. Their presence and relative concentration varied among the different spray colours. Often the layer of titanium dioxide particles detached from the mica substrate, and titanium dioxide particles were also observed forming near-spherical aggregates. STEM-EDX tomography allowed identifying particles of overlapping components and examining the structure of the pearlescent pigments in 3D. The presence of a fraction of nanoparticles in each component was demonstrated based on their number-based particle size distributions. The methods and findings support regulatory bodies in assessing potential health risks of mixtures of (nano)particles used in food-related applications.

**Keywords:** pearlescent pigments, sprays, electron microscopy, inorganic food additives, STEM-EDX

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