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# COMPREHENSIVE TWO-DIMENSIONAL SEPARATIONS FOR FOOD ANALYSIS

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Food products are very complex mixtures that contain nutrients of organic and inorganic structure. In addition to natural constituents, xenobiotic substances are often present, deriving mainly from agrochemical treatments, industrial processes, or packaging materials. Analytical methodologies must not only enable the qualitative and quantitative determination of the main food components, but also be sufficiently sensitive and selective to permit the determination of trace-amount constituents. The analysis of a food product can be directed towards a series of objectives, *viz.*, the control of an industrial process, the evaluation of nutritional values, the elucidation of aroma-impact volatiles and the detection of molecules with a possible beneficial or a toxic activity. It is hence obvious that there is a constant interest, amongst food chemists, towards the development and application of innovative and powerful analytical methodologies.

In recent years, food matrices have been widely analysed by using comprehensive two-dimensional chromatographic techniques (2D CC), in particular comprehensive 2D GC (GC x GC), 2D LC-GC (LC x GC) and 2D LC (LC x LC). The latter can be considered as innovative methods, and are gaining an excellent reputation as powerful analytical tools. The revolutionary aspect of comprehensive multidimensional (MD) techniques, with respect to classical MD chromatography, is that the entire sample is subjected to the 2D separation. The resulting unprecedented resolving power makes these approaches often an obliged choice when analysts are challenged with highly complex mixtures.

The present lecture is focused on the description of the fundamental aspects of GC x GC, LC x GC and LC x LC, current instrumental trends, as well as shortcomings and requirements. A variety of 2D CC food analysis experiments will be shown, highlighting the advantages of 2D techniques compared to the 1D counterparts, *viz.*, separation power, sensitivity, selectivity, speed (number of resolved compounds/unit of time) and structure (formation of 2D group-type patterns). The potential, and possible problems, of combining a third mass spectrometric dimension to a 2D CC system will also be discussed. Finally, a series of significant 3D CC-MS food applications will be illustrated.