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Capillary Electrophoresis and Taylor Dispersion Analysis: Recent Advances and Present Challenges in Health Applications

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Summary

In this presentation, the complementarity of Capillary Electrophoresis (CE) and Taylor dispersion analysis (TDA) will be exemplified for the characterization of biopharmaceutical samples, including mRNA loaded lipid nanoparticles (LNP) and vaccine formulations [1-3]. CE and TDA can be implemented on the same equipment, and share similar advantages (low injected volumes, automation of the analysis, and the absence of sample filtration). Combining CE and TDA allows determining both the charge and the size of the analytes, which are generally considered as critical quality attribute in the pharmaceutical industry. Taylor dispersion analysis (TDA) is a promising technique for the determination of diffusion coefficients and hydrodynamic radii of a myriad of nanoscale objects, including ultra-small nanoparticles (below 5 nm). The principle of this method is based on the band broadening of a solute plug injected in a miniaturized Poiseuille flow (50 µm i.d. capillaries). It allows determining the hydrodynamic radius of virtually any mixture of solutes, on a range of size ranking between 0.1 and 300 nm. TDA is insensitive to the presence of dusts (contrary to scattering techniques), and leads to a fair size distribution of the sample generally based on the weight-average of the constituents. With straightforward implementation, the absence of calibration, no filtration of the sample, TDA is a method of choice for the size-characterization of solutes in health applications.

Through various examples of applications, the advantages and limits of TDA and CE will be presented. For both techniques, one of the main limitations comes from solute adsorption. In the case of CE, we recently deciphered and quantified the impacts of electroosmotic heterogeneity and solute adsorption on peak broadening for intact protein separations in polyelectrolyte multilayer (SMIL) coated capillaries [4]. This could be realized by the systematic experimental determination of the curve representing the plate height H versus the solute velocity u. In optimized conditions, very efficient and repeatable protein separations could be obtained using SMIL coatings. In the case of TDA, the impact of solute adsorption can be greatly limited experimentally by using a “plug-in-front” methodology.

References

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