Current Status and Future Trends of NIR Spectroscopic Analysis of Foods

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The ability of straightforward on-site usage, non-destructive analysis of samples featuring wide variety in chemical composition and physical form, while remaining sensitive to the chemical fingerprint is the hallmark of NIR spectroscopy (Bec and Huck, 2020). High performance, sensitivity, reproducibility with low methodological development costs, accompanied by the capacity to perform through-package analysis, makes NIR technique particularly valued in food quality control. In the near future, the problem of food quality control will be one of the most important and focused topics in the public debate, where the food risk is seen two-fold, intentional or accidental; to address both, new, powerful and efficient analytical methods need to be established (Charlebois et al., 2016). NIR spectroscopy appears as one of the most promising analytical frameworks for fulfilling this urgent demand.

In general, the design principles of the NIR instrumentation (spectrometers, optics, cells, sample handling) guarantee a wide area of expansion in the currently rapidly diversifying food production and supply chain. The possibility of high sample volume and fiber probe instrumentation enables a fundamental reduction of the necessity of sample preparation. One of the most up-to-date breakthroughs is the sensor miniaturization. Low-cost, portable NIR spectrometers have become reality, and in the next few years, with ultra-miniaturized spectrometers directly integrated smartphone devices being developed nowadays (Bec, Grabska and Huck, 2021). Currently, there are two major trends in advancing NIR spectroscopy in food analysis which are followed in our working group. The first is the development and employment of miniaturized NIR sensors for approaches in the discussed fields. The second trend is the implementation of innovative frameworks for spectra interpretation and calibration, where quantum chemistry provides deeper understanding about the performance of individual spectrometers and chemometric models, respectively.

**Keywords:** sensor fusion, chemical interpretation of calibration models, in silico NIR spectroscopy

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