

# Visible-NIR ‘point’ spectroscopy in postharvest fruit and vegetable assessment: The science behind three decades of commercial use

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## Abstract

The application of visible (Vis; 400–750 nm) and near infrared red (NIR; 750–2500 nm) region spectroscopy to assess fruit and vegetables is reviewed in context of ‘point’ spectroscopy, as opposed to multi- or hyperspectral imaging. Vis spectroscopy targets colour assessment and pigment analysis, while NIR spectroscopy has been applied to assessment of macro constituents (principally water) in fresh produce in commercial practice, and a wide range of attributes in the scientific literature. This review focusses to key issues relevant to the widespread implementation of Vis-NIR technology in the fruit sector. A background to the concepts and technology involved in the use of Vis-NIR spectroscopy is provided and instrumentation for in-field and in-line applications, which has been available for two and three decades, respectively, is described. A review of scientific effort is made for the period 2015 - February 2020, in terms of the application areas, instrumentation, chemometric methods and validation procedures, and this work is critiqued through comparison to techniques in commercial use, with focus to wavelength region, optical geometry, experimental design, and validation procedures. Recommendations for future research activity in this area are made, e.g., application development with consideration of the distribution of the attribute of interest in the product and the matching of optically sampled and reference method sampled volume; instrumentation comparisons with consideration of repeatability, optimum optical geometry and wavelength range). Recommendations are also made for reporting requirements, viz. description of the application, the reference method, the composition of calibration and test populations, chemometric reporting and benchmarking to a known instrument/method, with the aim of maximising useful conclusions from the extensive work being done around the world.