**Identification of new psychoactive substances using Raman spectroscopy: handheld and computational approaches**

**Amira Guirguis,1** Stewart B Kirton,1 Mire Zloh**,1** Eleftherios Samaras**,1** Sarah Girotto**,1** Benedetta Berti**1** and Jacqueline L Stair1

1 School of Life and Medical Sciences, Department Pharmacy, University of Hertfordshire, Hatfield, AL10 9AB, United Kingdom.

The heterogeneity and diversity of new psychoactive substances (NPS) add challenges to their detection using conventional on-site techniques. The aim of this work was to evaluate different handheld Raman instruments, build a library using representative NPS selection and develop computational models capable of detecting NPS in complex mixtures. Two handheld Raman spectrometers, with laser excitation wavelengths of 785 and 1064 nm, respectively, were employed in the identification of 60 NPS internet products. Using both benchtop and handheld Raman spectroscopy, libraries were built using reference standards for 53 NPS, eight adulterants and 12 cutting agents. Twelve NPS reference standards and NPS mixtures with known composition were employed to evaluate method robustness. Results have shown a significant improvement in the number of NPS detected when the instrument with the longer excitation wavelength (1064 nm) was used. These are attributed to the reduction in fluorescence background signal observed with the lower excitation wavelength (785 nm) laser. Pre-processing of Raman spectral data has improved the classification of NPS-like mixtures and was validated using test samples. Classification of NPS mixtures based on a discrete number of NPS in the library was made possible using computational chemometrics models. In conclusion, Raman spectroscopy employing a laser wavelength of 1064 nm has shown promise as a handheld technique for the on-site identification of NPS products. Coupling of chemometrics with Raman spectroscopy has significantly improved the identification of NPS in complex mixtures. Further studies are needed to refine the classification of emerging NPS analogues and improve the computational models.