Evaluation and Identification of Blood Stains in Crime Scenes with ultra-portable NIR Spectrometer

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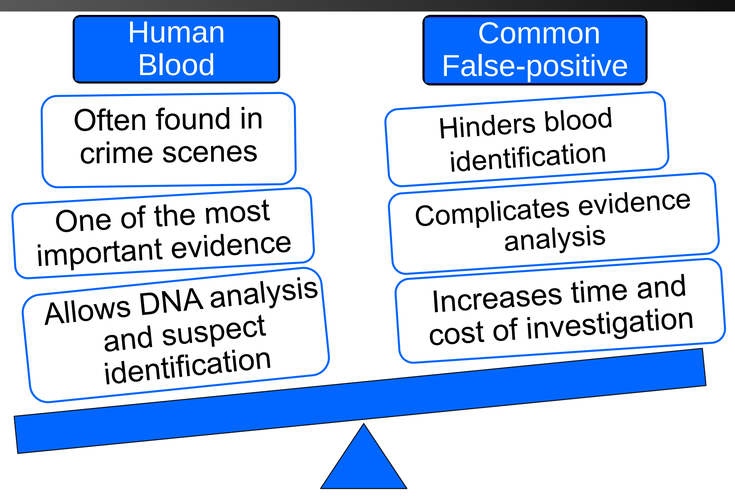
Introduction

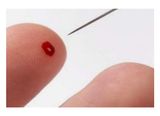


Objective: Develop a methodology for analysis of suspicious blood stains at crime scenes that allows unequivocal identification of human provenance by near infrared spectroscopy (NIR), with a handheld instrument, associated to the multivariate classification technique PLS-DA.

Material and Methods

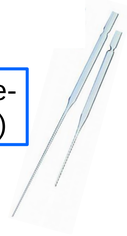
Sample Preparation:

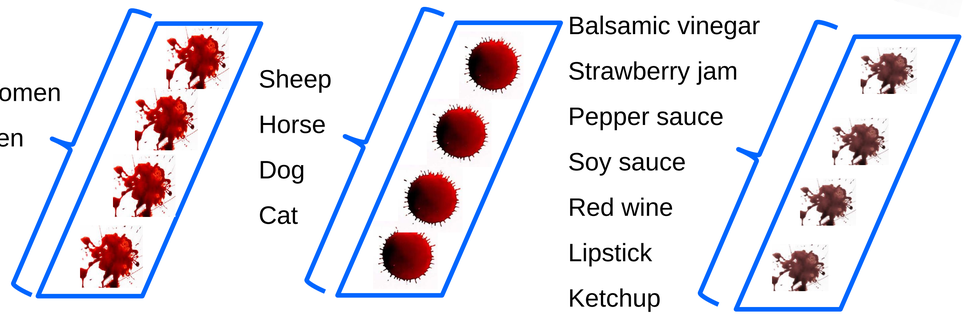
Human Blood (HB)



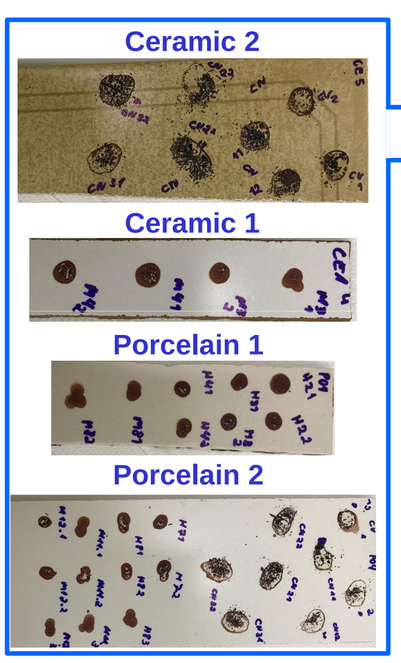
Animal Blood (AB)

Common False-Positive (CFP)

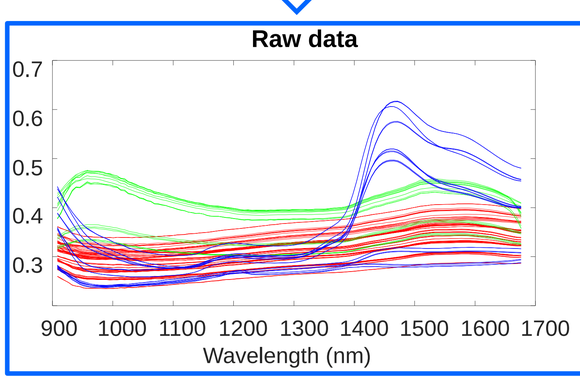




Spectral acquisition in triplicate with spectrometer microNIR 1700



Spectral acquisition: Range 908 to 1676 nm, spectral resolution 12.5 nm, 50 scans.



PLS-DA

Tab1. Resume of samples spectra acquisition.

Substrate	Samples (nº of spectra)		
	HB	AB	CFP
Porcelain 2 x ceramic 1	96	57	105
Ceramic 1 x ceramic 2	110	64	105
Porcelain 1 x Porcelain 2	108	57	105
Porcelain 1x ceramic 1 *	116	64	105

*** Only cat and dog blood samples**

Results and Discussion

- ✓ Spectral preprocessing techniques tested: normalization (max/area/range), SNV, 1ª e 2 ª deriv. SG, Smooth SG filter (2 order polynomial, window of 7-15 points), mean center;
- ✓ Generalized least-squares weighting (GLSW) was applied to reduce the influence of different substrates used in a same model;
- ✓ Best results: smooth SG filter (2ª order polynomial, 9 points window), normalization by area, GLSW and mean center.

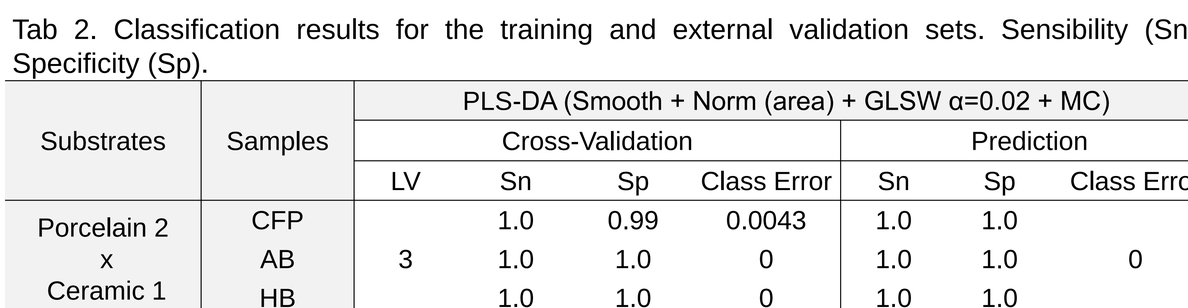
Tab 2. Classification results for the training and external validation sets. Sensibility (Sn), Specificity (Sp).

Substrates	Samples	PLS-DA (Smooth + Norm (area) + GLSW α=0.02 + MC)						
		Cross-Validation				Prediction		
		LV	Sn	Sp	Class Error	Sn	Sp	Class Error
Porcelain 2 x Ceramic 1	CFP	3	1.0	0.99	0.0043	1.0	1.0	0
	AB		1.0	1.0	0	1.0	1.0	
	HB		1.0	1.0	0	1.0	1.0	
Ceramic 1 x Ceramic 2	CFP	5	1.0	1.0	0	0.94	0.99	0.033
	AB		1.0	1.0		1.0	0.98	0.0089
	HB		1.0	1.0		1.0	0.97	0.013
Porcelain 1 x Porcelain 2	CFP	6	1.0	1.0	0	0.96	1.0	0.019
	AB		1.0	0.98	0.0090	1.0	0.99	0.0054
	HB		0.98	0.99	0.011	0.97	0.96	0.033
Porcelain 1 x Ceramic 1	CFP	3	1.0	1.0	0	1.0	1.0	0
	AB *		1.0	1.0		1.0	1.0	
	HB		1.0	1.0		1.0	1.0	

*** Only cat and dog blood samples**

Example of Scores for Prediction from two models

Ceramic x Porcelain | **Ceramic x Ceramic**



Models built with samples prepared on same kind of substrates show the worst results, maybe due to differences in the pigments. Models combining different substrates present more suitable results.

Conclusion

There were **no false negative to human blood** and although few samples were misclassified, results show the potential of handheld MicroNir and PLS-DA to unequivocally identify human blood stains on different floor tiles in a fast, non-destructive and reliable way.

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CAPES

NEQUIFOR

Pro-forenses