Collagen Toolbox 2.0

Incorporation of Hyperspectral Imaging as A Non-invasive Characterisation Tool

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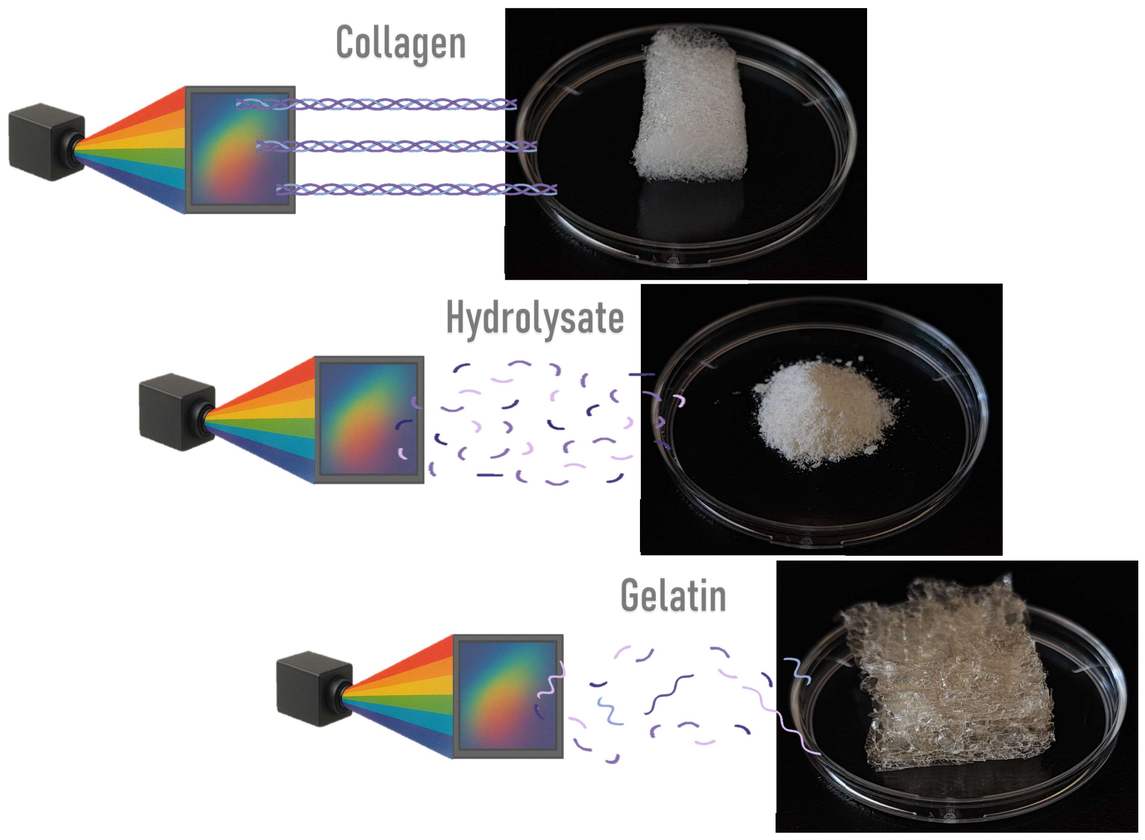
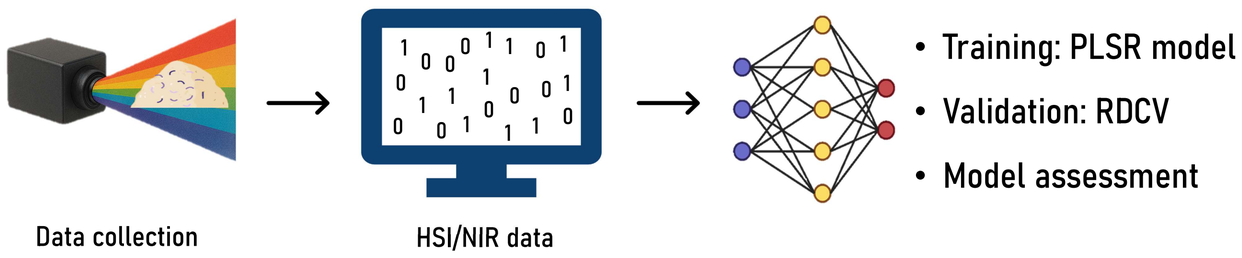
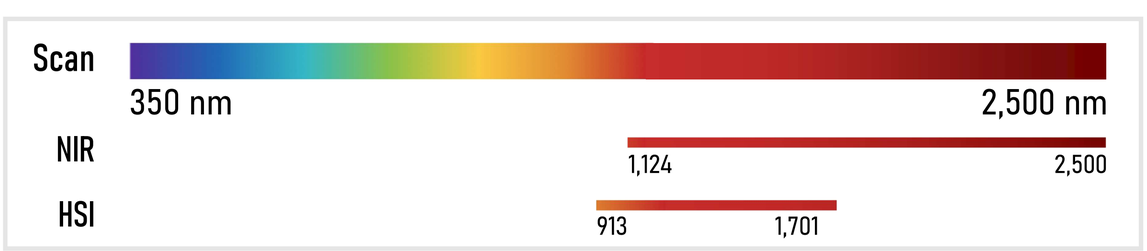
As part of LASRA's initiative to advance collagen research and commercialisation in New Zealand, we developed an analytical platform, Collagen Toolbox. This toolbox is designed to address the diverse needs of the industry and research sectors while providing essential information for regulatory compliance. It offers comprehensive support for characterising collagen and its co-products, drawing from our existing in-house database. The roadmap for our toolbox expansion includes the integration of hyperspectral imaging (HSI) as a non-invasive and cost-effective characterisation method. HSI is an analytical technique that combines high-resolution imagery with spectroscopy and digital imaging. This technology collects data across the electromagnetic spectrum, capturing the spectrum for each pixel in an image. These spectral signatures could potentially enable us to determine collagen purity, moisture content, sample form (i.e., intact, hydrolysed, or gelatinised), impurities, etc. Here, we looked into the selection of different collagen samples extracted from different species or sources to develop a prediction model of stipulated quality indexes based on HSI technology. Our preliminary results showed that spectral data could capture unique signatures from different sample types across various sources. The performance and the validation of the developed models are discussed.

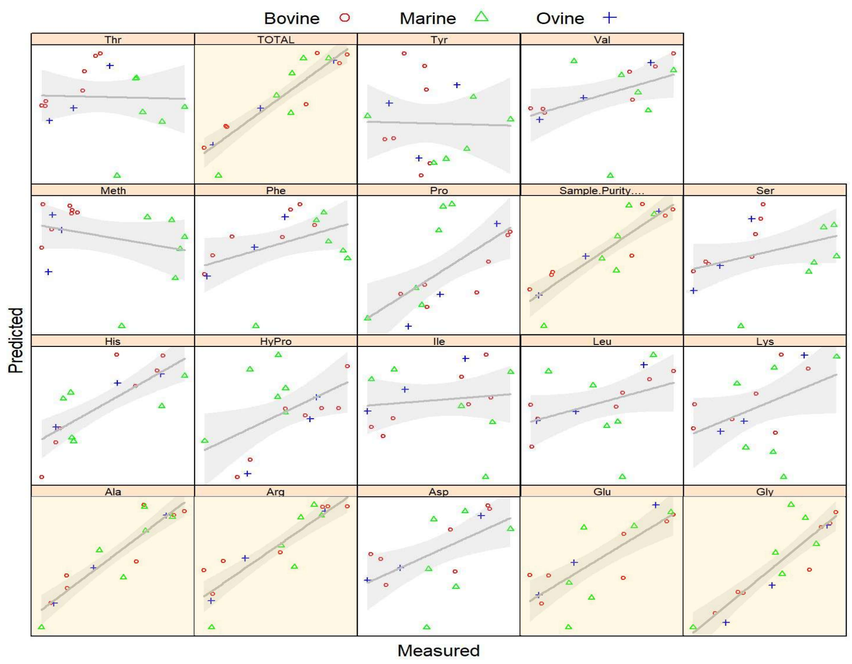
Research question:
Can hyperspectral imaging, informed by sample amino acid profiling, effectively differentiate collagen co-products?



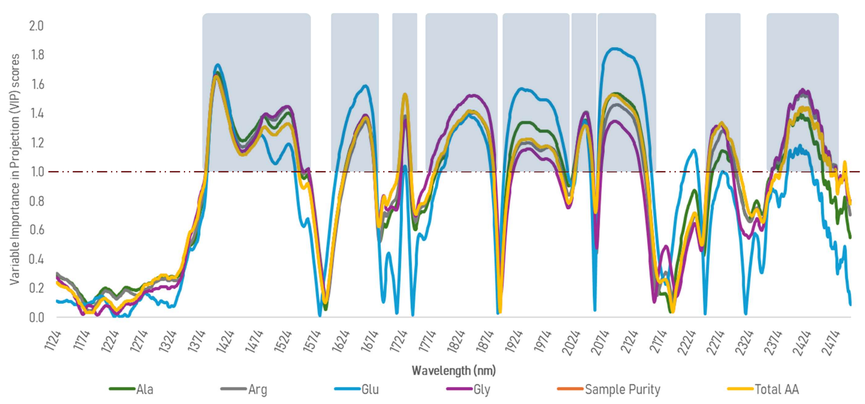




Predictor Plot: NIR

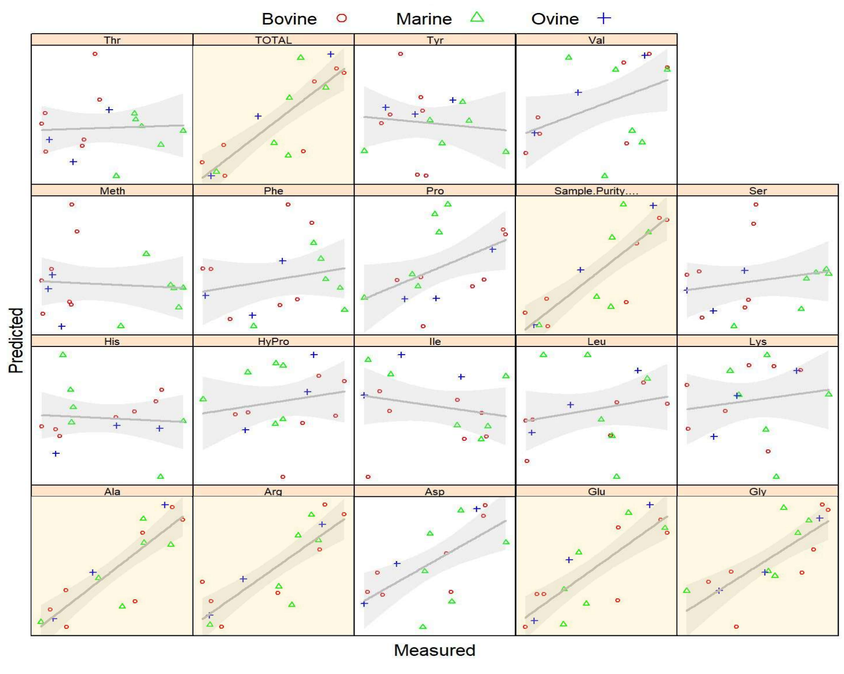


VIP-SNV plot: NIR

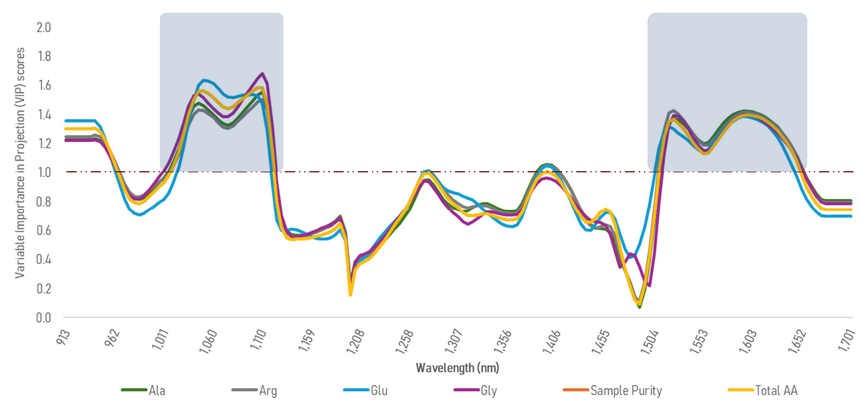


Attribute	R^2	Components	SEP	MSE	RMSE
Ala	0.84	2	8.71	75.79	8.71
Total AA	0.84	2	95.67	9105.08	95.42
Arg	0.81	2	8.81	77.47	8.80
Gly	0.80	2	29.29	865.71	29.42
Sample Purity	0.79	2	0.10	0.01	0.10
Glu	0.63	1	14.60	212.17	14.57

Predictor Plot: HSI



VIP-(SNV + 1st derivate) plot: HSI



Attribute	R^2	Components	SEP	MSE	RMSE
Ala	0.74	2	11.69	137.56	11.73
Arg	0.70	2	10.93	118.74	10.90
Total AA	0.70	2	109.33	11996.03	109.53
Sample Purity	0.69	2	0.12	0.01	0.12
Glu	0.68	2	13.29	177.93	13.34
Gly	0.60	2	35.83	1278.59	35.76

Our previous work demonstrated the feasibility and potential of utilising hyperspectral imaging (HSI) technology for assessing hide quality and enabling leather traceability.[1,2]

Partial least squares regression (PLSR) models were developed using hyperspectral and Near-InfraRed spectral data, based on:

- a panel of 17 amino acids;
- sample purity (%) and;
- total amino acid.

Repeated double cross-validation (RDCV) was employed to ensure robust modelling. This approach is particularly suitable for small datasets and helps minimise the risk of overfitting.[3]

All models were developed using both hydrolysate and gelatin samples. Collagen samples were excluded owing to constraints in sample morphology that impeded reliable spectral data collection.

Alanine, glutamine, arginine, glycine, total amino acid, and sample purity exhibited strong predictive performance.

Among these, alanine showed the highest model accuracy.

ACKNOWLEDGEMENT

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REFERENCES

[1] 10.1016/j.saa.2022.122220
[2] SSRN 5337920
[3] 10.1007/s00216-020-03093-7