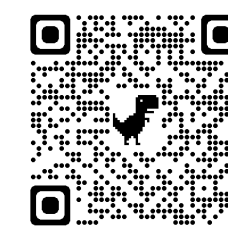


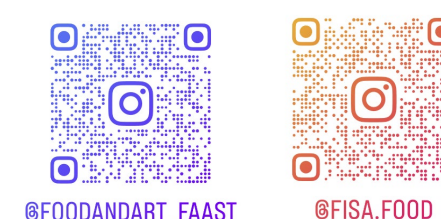
Authentication of Halal and Kosher Meat Products by High Performance Liquid Chromatography with Ultraviolet (HPLC-UV) Fingerprinting and Chemometrics

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INTRODUCTION & AIM

Meat fraudulent practices regarding product labelling, substitution and adulteration are common, requiring feasible analytical techniques to address meat authentication issues. Frauds of relevant importance are those involving cultural/religious practices such as Muslim countries (Halal products) where the consumption of pork is prohibited, or the case of Kosher products in the Jewish communities. Although the substitution on animal species can be easily solved by genetic detection tools based on DNA determination, other Halal and Kosher meat authentication issues, where the way in which animals permitted for consumption are slaughtered, or how the meat products are processed, cannot be solved by genetics. In these cases, metabolomic fingerprinting strategies are emerging as good options to address Halal and Kosher meat authentication issues not based on animal species.

The aim of the present contribution is to evaluate the capability of a non-targeted HPLC-UV (at 280 nm) metabolomic fingerprinting methodology in combination with chemometrics to address Halal and Kosher meat authentication after a simple sample water extraction with water. The obtained HPLC-UV fingerprints were employed as sample chemometric descriptors for exploratory principal component analysis (PCA) and classificatory partial least squares-discriminant analysis (PLS-DA). In addition, the potential HPLC-UV fingerprinting to detect and quantify Halal and Kosher meats adulterated with non-Halal and non-Kosher products (of the same meat species) was assessed by partial least squares (PLS) regression.

METHOD

SAMPLES

CONVENTIONAL MEAT



Beef (20)

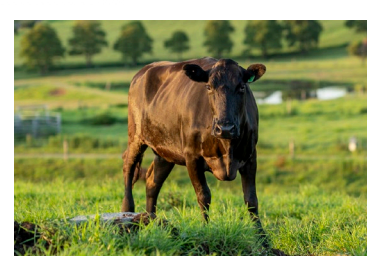


Lamb (20)

HALAL MEAT



Halal Lamb (20)



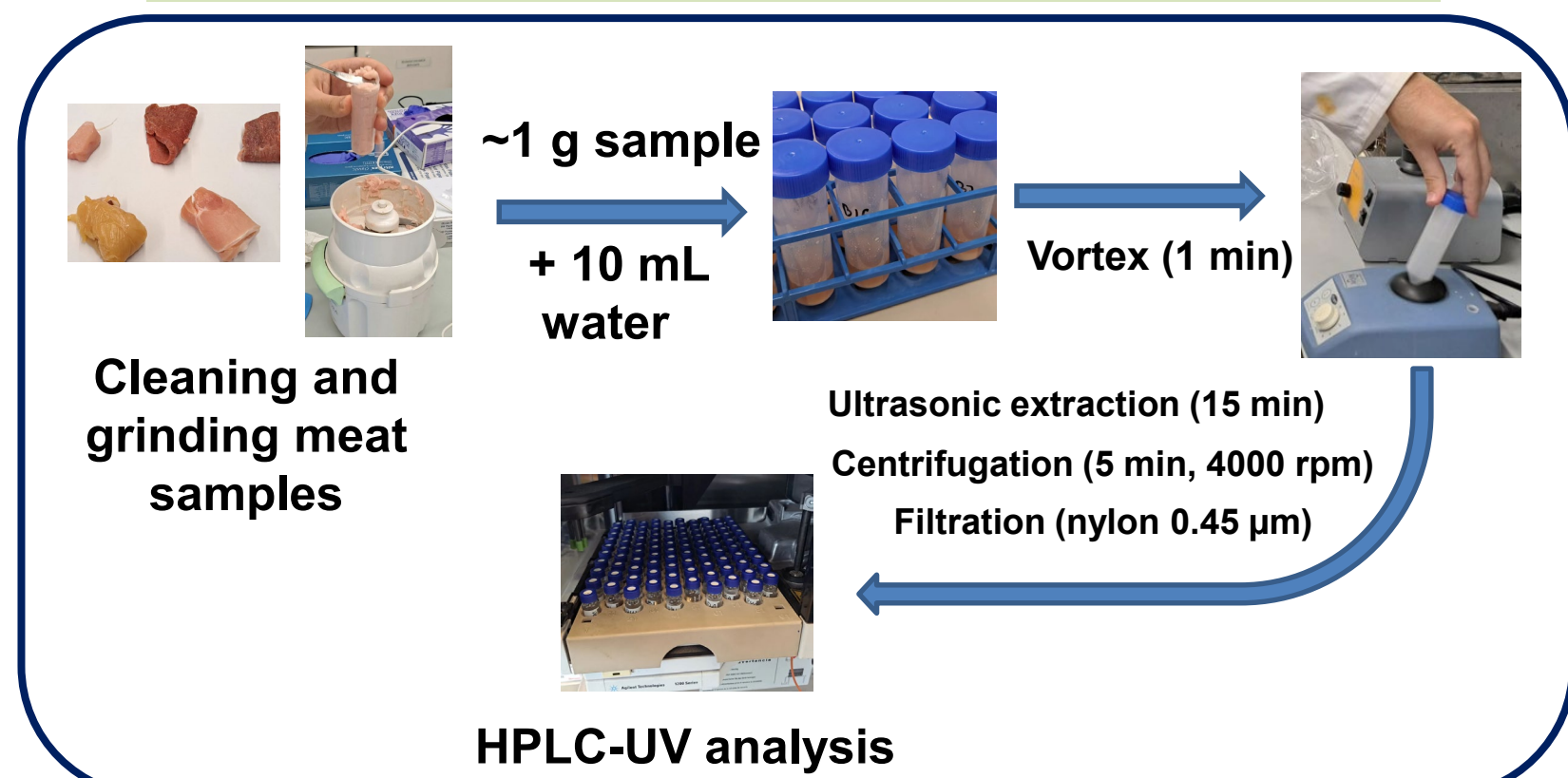
Halal Beef (20)

KOSHER MEAT



Kosher Beef (20)

SAMPLE TREATMENT



NON-TARGETED HPLC-UV- FINGERPRINTING METHOD

Instrument: Agilent 1100 Series HPLC

Column: Kinetex C18 (10 cm × 4.6 mm, 2.6 µm)

Mobile phase:

A. Water with 0.1% formic acid

B. Acetonitrile

Flow-rate: 400 µL·min⁻¹

Gradient:

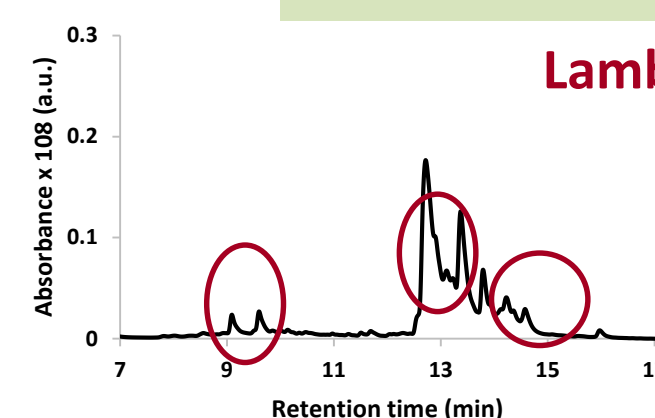
Time [min]	Solvent B [%]	Elution mode
0-1	3	Isocratic
1-20	3-95	Lineal
20-22	95	Isocratic
22-22.1	95-3	Lineal
22.1-25	3	Isocratic

UV acquisition: 280 nm

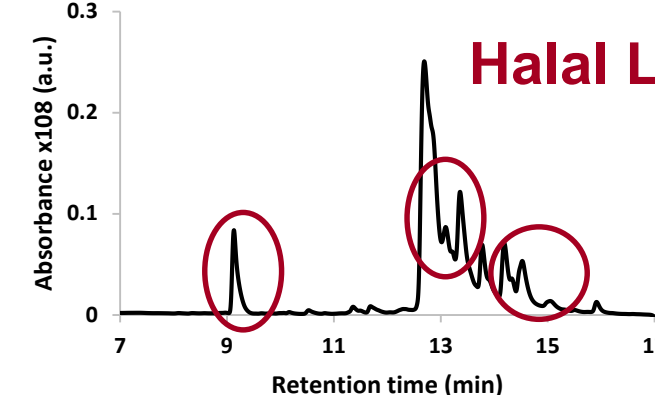
Injection volume: 5 µL

RESULTS & DISCUSSION

ANALYSIS OF LAMB SAMPLES

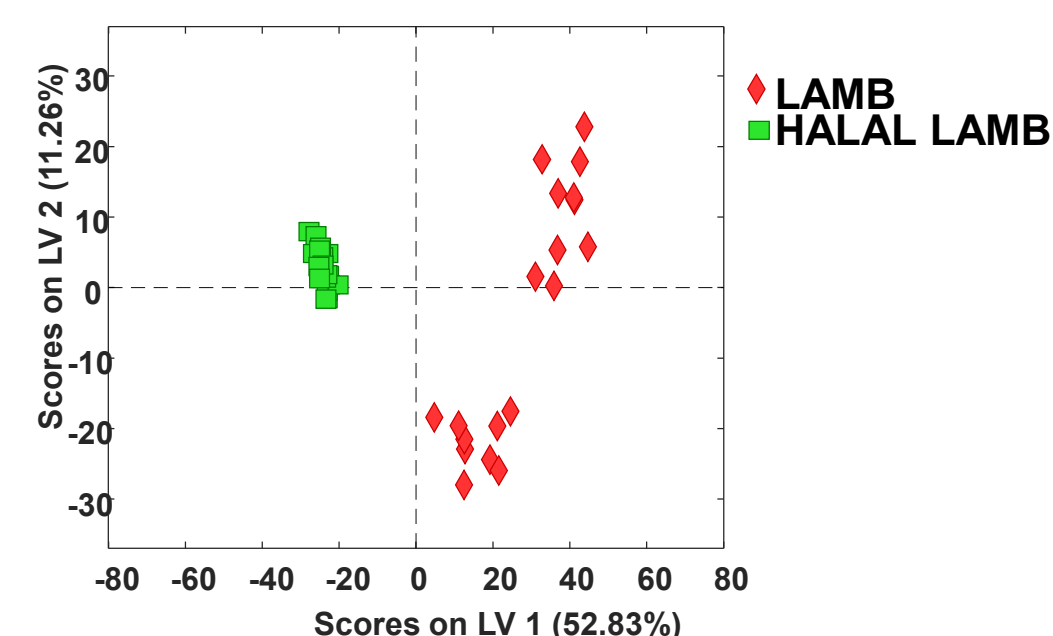


Lamb



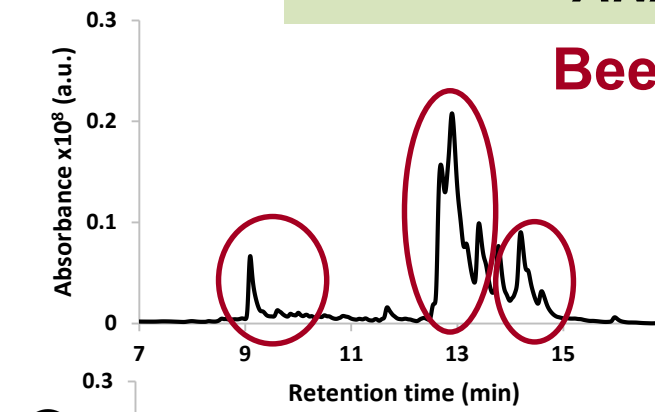
Halal Lamb

PLS-DA results

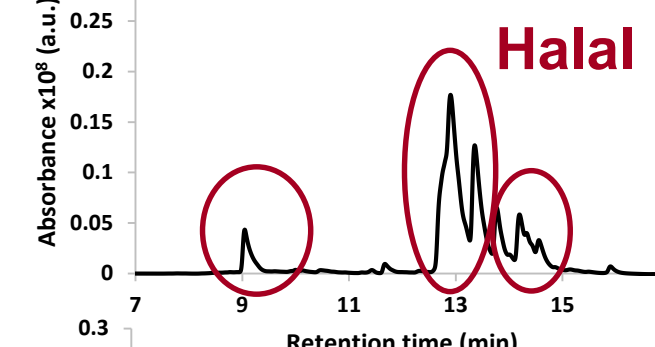


Perfect discrimination when addressing Halal Lamb samples

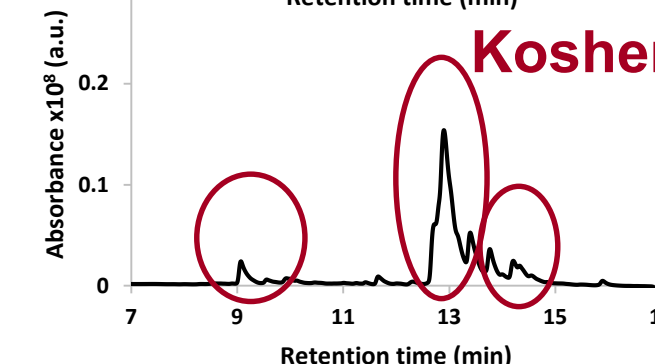
ANALYSIS OF BEEF SAMPLES



Beef

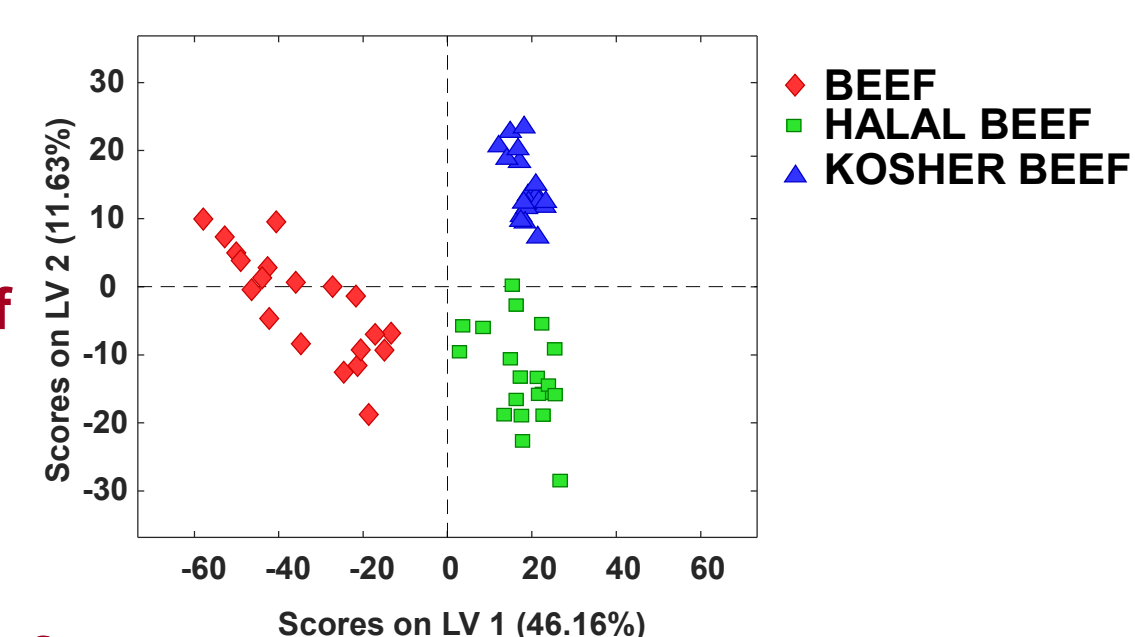


Halal Beef



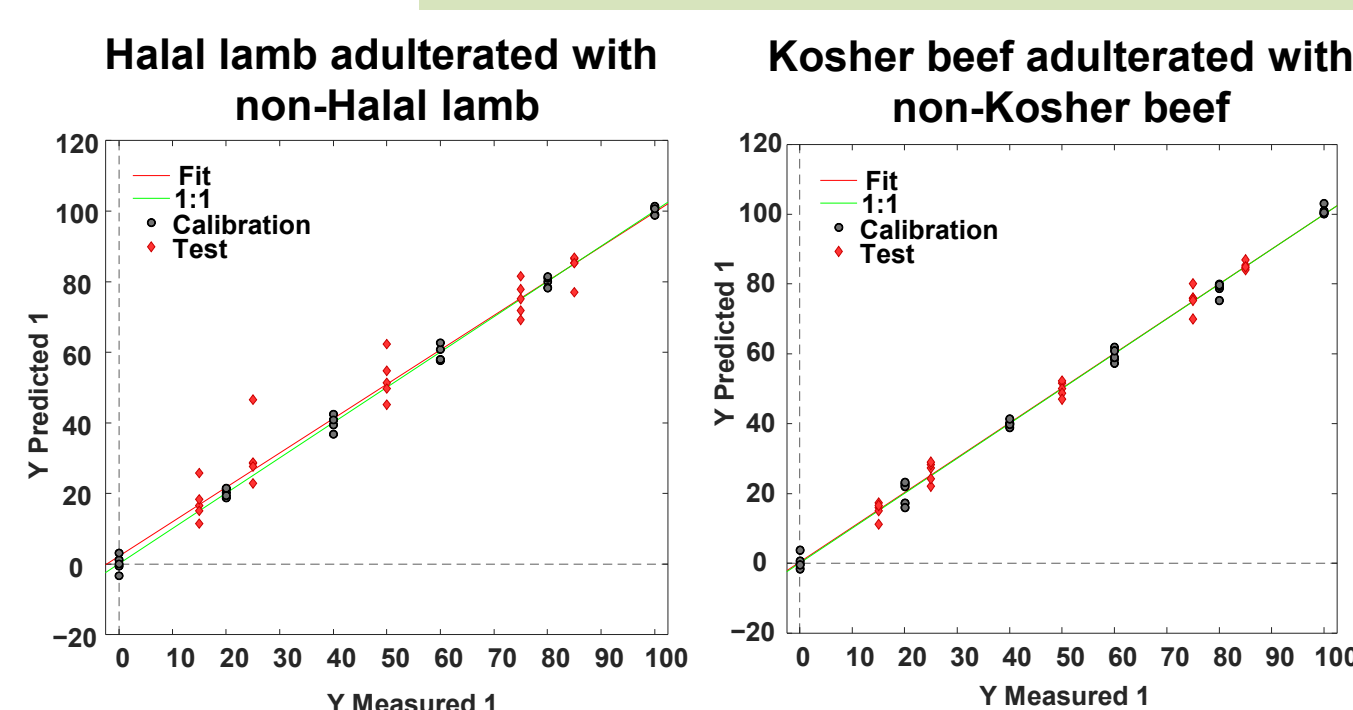
Kosher Beef

PLS-DA results



Perfect discrimination when addressing Halal and Kosher Beef samples

ADULTERATION DETERMINATION BY PLS



PLS regression performance

Linearity: 0.966 - 0.998
Calibration error: 1.7 - 6.2 %
Cross-Validation error: 3.9 - 7.9 %
Prediction error: 2.4 - 6.4 %

CONCLUSIONS

PLS-DA classification performance was excellent, with sensibility and specificity values of 100%, and 100% accuracy on sample classification ratio. Very good PLS calibration, cross-validation, and prediction errors were obtained, demonstrating the capability of the proposed HPLC-UV metabolomic fingerprinting strategy to address meat authentication issues that cannot be solved by genetic analyses, such as those addressing Halal and Kosher products.

REFERENCES

- A. Santomà-Martí, N. Aijon, O. Núñez. "Meat Authentication Based on Animal Species and Other Quality Meat Attributes (Protected Geographical Indication, Organic Production, and Halal and Kosher Products) by HPLC-UV Fingerprinting and Chemometrics", Food Analytical Methods 18 (2025) 1825-1841. <https://doi.org/10.1007/s12161-025-02840-9>

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