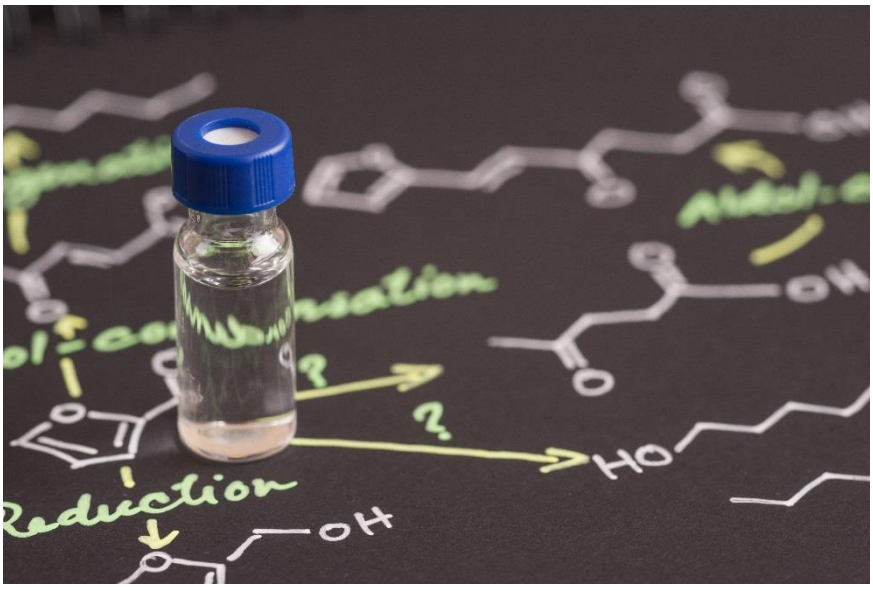
Technical bulletin 1: testing of new technologies – REIMS



Meat speciation: The Lipidomic approach

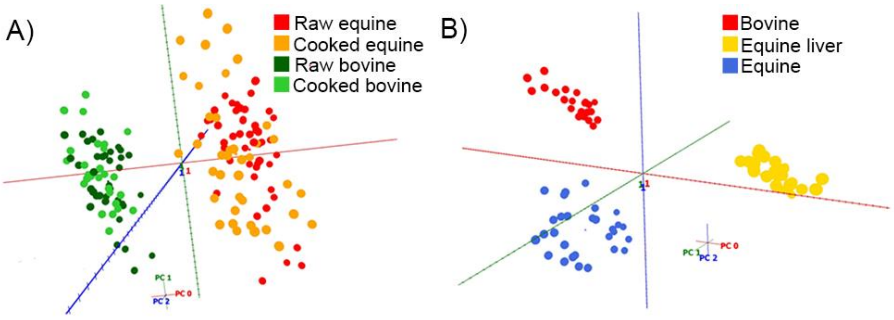
Food fraud can involve any food commodity and can take the form of substitution fraud, addition fraud or even country of origin fraud. This was highlighted during the horse meat scandal of 2013 and the subsequent *Elliott Review into the Integrity and Assurance of Food Supply Networks* by Prof Chris Elliott of Queen's University Belfast. Food fraud is estimated to cost the global agrifood sector an estimated $40 billion per annum. Tackling this issue requires, among other things, the development of rapid analytical methods that can be used to determine the authenticity and content of food samples. This technical bulletin describes research carried out at Queen's University Belfast on the application of one such method in determining the authenticity of meat samples.

Lipidomics is the study of the lipidome, i.e. the lipid profile within a cell, tissue, organism, or ecosystem. Rapid Evaporative Ionisation Mass Spectrometry (REIMS) is one of the newest forms of Accelerator Mass Spectrometry (AMS) and, as is the case with many analytical innovations, was created for medical research purposes. This lipidomics-based technique operates using an electrosurgical knife which creates an aerosol (smoke) when cutting into a tissue sample (Figure 1). The aerosol is evacuated from the surgical site through a vent line into a mass spectrometer where a heated capillary is situated and the ionisation process occurs.

The project team explored the applicability of REIMS profiling with regard to the species- and breed-level differentiation of raw and cooked meat products (including horse meat). The spectra produced were data-mined, pre-processed and used to generate chemometric models such as Principal Component Analysis (in this case Linear Discriminate Analysis (LDA)) calibration. Figure 2 shows (a) the separation of beef and horsemeat, (b) separation of horse meat, horse liver and beef. LDA models are shown in Figure 3 showing how lipidomic data can be used to differentiate between breeds and species.

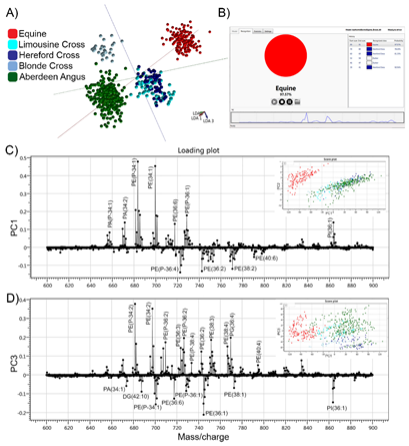
Figure 1: REIMS source and QTof-MS coupled to the electrosurgical knife

Figure 2. Identification of different products and effect of cooking on mass spectra.

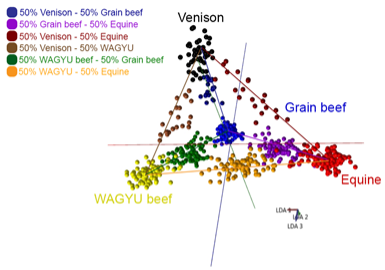


A) Three- dimensional Principal Component Analysis (PCA) plot of raw and cooked Angus beef and horse meat. The preparation of sample has clearly no effect on the differentiation of the species. B) Three-dimensional PCA plot of two different horse organ products and beef. A clear separation can be observed on the PCA plot.

Figure 3: (i) Pseudo 3-dimensional plot of data obtained by the analysis of 4 different bovine breed (Limosine, Hereford, Blonde & Aberdeen Angus) and equine samples with a 97.5% classification rate; (ii) Pseudo 3-dimensional plot of products from 4 different species (Wagyu beef, grain beef, venison & horse meat) and the 1:1 mixture with a 97.8% classification rate.



(i) 97.5% Classification Rate



(ii) 97.8% Classification Rate

This was the first time the application of REIMS for the rapid lipidomic profiling of food-grade meat products has been successfully performed. The lipidomic profiles can be recorded in a few seconds and the profiles show good animal species-level specificity. Furthermore, the results obtained for Angus and Wagyu beef implies that the method shows some sub-species (e.g. breed) selectivity and can potentially also be used to detect even finer differences such as the geographic origin.