Food fraud is a collective term used to encompass the deliberate and intentional substitution, addition, tampering, or misrepresentation of food, food ingrediants, food packaging, or false or misleading statements made about a product for economic gain. Due to their high market values, meat and fish products are often targets for species substitution and adulteration. Introduction of undeclared species into the food chain is a significant problem for consumers from an ethical or religious viewpoint, could be a serious risk for those with food allergies and undermines confidence in food chain traceability and safety. Meat and fish can pass through many different stages, spread out through many countries, before appearing at retailers as a processed product.

Testing food is one of the key ways of checking whether food businesses are complying with food law. Current methods used for determination of species and adulteration are time consuming, costly and typically located in a laboratory some distance from the food chain.

Rapid Evaporative Ionisation Mass Spectrometry (REIMS) is an emerging technique that allows rapid characterization of biological tissues [1,2]. We demonstrate here that REIMS is able to differentiate meat and fish samples originating from different species, regardless of which tissue is chosen.

METHODS

Commercial and authenticated samples of different types of meat and fish were procured and supplied by collaborators. All samples were analyzed using the i-Knife to cut the tissue surface.

The i-Knife hand-held sampling device applies a high frequency electric current to the tissue via a diathermic process. This causes localized heating that cuts into the tissue. The tissue or aerosol produced contains gas-phase clusters of ionised and neutral species. It is transferred from the cutting location on the surface of the tissue through PTFE tubing into the transfer capillary by a Venturi air jet pump-based transfer device mounted in the orthogonal position relative to the atmospheric interface of the mass spectrometer. Decelerating takes place at the heated impactor surface and gas-phase ions pass into the quadrupole of the time-of-flight mass spectrometer (Xevo G2-XS). Data for each “burn” are acquired operating in negative ionisation mode over a typical mass range of m/z 100-1000. Leucine enkephalin (LE), to be used as a lock mass, is also introduced into the ion source via infusion in 2-propanol. The presence of 2-propanol has also been shown to enhance the response for lipids in REIMS in negative ion mode. Lock mass correction, adaptive background subtraction and normalization are all performed by the software post acquisition.

The applications presented here use REIMS coupled with multivariate statistics and prototype software for real-time recognition. Classification of unknown samples against the models, created from spectra in the database does not require excessive computational operations so the process can be completed in seconds. A simple ‘burn’ of sample is sufficient (e.g. red light/green light).

The i-Knife has the potential for classification and real-time recognition of a meat sample.

The results indicate that the rapid analysis of animal tissues can be achieved with no sample preparation required, which is critical for on-line systems. It is envisaged that REIMS will find applications in the food and beverage sector for authentication and traceability initiatives, and for on-line and in-line monitoring and quality control of fresh and processed foods and beverages.

REFERENCES


CONCLUSION

Combining REIMS with multivariate statistics provides a useful tool for the rapid analysis of animal tissues with no sample preparation required
- Non compliant samples may be investigated further using established techniques; e.g. those based upon DNA or proteomics
- We have demonstrated the potential for the determination of both species and level of adulteration in fish and meat using a prototype system for real-time recognition of animal tissues using a spectral database that will be commercialized in June
- Initial objective is to provide a research tool for the development of databases but the vision is for an instrument that could be placed at the source of production or critical points along the supply chain.

Table 1. Results of cross validation (20% of group left out)

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<tr>
<th>Fish speciation (with Queen University Belfast)</th>
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<tbody>
<tr>
<td>1. Fish speciation (with Queen University Belfast)</td>
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<tr>
<td>2. Analysis of different meats and meat products (with Istituto Zooprofilattico Sperimentale, Bologna)</td>
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Figure 1. Photograph showing the cutting of the tissue surface using the i-knife and schematics of the i-TOF MS used for REIMS and the output from each “burn”

Figure 2. Schematic showing how the aerosol is sampled, how ions are formed and transferred to the i-TOF MS