Detection of offal adulteration in minced beef products using Near-Infrared (NIR) spectroscopy

Wenyang Jia1\*, Saskia van Ruth2\*, Nigel Scollan1\*, Anastasios Koidis1\*

1 Institute for Global Food Security, School of Biological Sciences, Queen's University, 19 Chlorine Gardens, Belfast BT9 5DL, Northern Ireland, UK, [IGFS@qub.ac.uk](mailto:IGFS@qub.ac.uk)

2 Food Quality and Design Group, Wageningen University and Research, P.O. Box 17, 6700 AA, Wageningen, the Netherlands, [into@wur.nl](mailto:into@wur.nl)

Adulteration in meat products is always one of the significant frauds, with intentional or economically reasons driving its occurrence. Due to the nature of the ground beef and the adulterants involved this is not easily detectable, and it is also unsafe for the downstream supplier or the end consumer. The current DNA based detection method can achieve high precision but is costly, cumbersome, and time-consuming. Near-Infrared (NIR) spectroscopy, as a non-destructive and rapid technique, can explore the differences between authentic and adulterated products based on the variance of the detailed profile, which will significantly shorten the time to identify the unknown problem. NIR has proved that it can quickly detect adulteration of minced meat products (Leng et al., 2020). However, previous work focused on adulteration from exogenous sources, and little evidence on the adulteration of ground meat from endogenous sources. Therefore, this work uses NIR in untargeted reflection mode to detect adulteration of minced beef including different animal-derived adulterants (beef offal such as liver and heart). Minced beef products are made from the less desirable cuts (chuck), which is often labelled as "lean ground beef” and used for blending it into burgers and meatballs. In this study a battery of machine learning methods are used to train the calibration models of the NIR signals (Partial Least Squares-Discriminant Analysis Support Vector Machine-Discriminant Analysis, Classification and Regression Tree and Back Propagation Artificial Neural Networks). Results have shown that the NIR can distinguish between pure and adulterated samples very well (accuracy >80%). The overall quality parameter (KAPPA) was also used to evaluate the classification model (Jiménez-Carvelo et al., 2017). Overall, NIR has the potential to achieve the designed requirements of online/remote, real-time/testing platform for minced beef authenticity.

**Keywords:** Near-Infrared, Mixture adulteration, Meat, Chemometrics, Machine learning

**Acknowledgements:** The authors would like to acknowledge the financial support for this research from the Queen's University Belfast (QUB) and China Scholarship Council (CSC) (QUB-CSC).

**REFERENCES**

Leng, T., Li, F., Xiong, L., Xiong, Q., Zhu, M. and Chen, Y., 2020. Quantitative detection of binary and ternary adulteration of minced beef meat with pork and duck meat by NIR combined with chemometrics. Food Control, 113, p.107203.

Jiménez-Carvelo, A., Osorio, T., Koidis, A., González-Casado, A. and Cuadros-Rodríguez, L., 2017. Chemometric classification and quantification of olive oil in blends with any edible vegetable oils using FTIR-ATR and Raman spectroscopy. LWT, 86, pp.174-184.