

Use of NIR Spectroscopy from beef authentication of farmers' practices

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Why is this important?

Consumers increasingly seek trustworthy information about the origin and production systems of beef. Claims related to origin, housing conditions, production systems and breed characteristics can influence purchasing decisions and product value. However, verifying such claims often requires expensive and time-consuming analytical methods. Near-infrared (NIR) spectroscopy offers a rapid, non-destructive and cost-effective alternative that can support authentication and traceability throughout the beef supply chain.

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What was done?

The INTAQT project evaluated the ability of NIR spectroscopy combined with chemometric models to authenticate production-related characteristics in beef. A total of 413 beef samples from Switzerland, France, Spain and the United Kingdom were analysed using three different NIR technologies:

FoodScan (NIT), DS2500 (VIS/NIR) and SCiO portable NIR. Samples represented different production cycles, animal categories, housing systems and genetic production types. In addition, 135 carcasses were scanned directly in abattoirs using portable devices to assess the feasibility of real-time authentication under commercial conditions.

Main results

The study demonstrated that NIR spectroscopy can successfully identify several important beef production attributes.

Country of origin.

- Models achieved high accuracy for country-of-origin authentication, particularly for Swiss and French beef.
- Portable NIR devices used in abattoirs accurately distinguished Swiss and UK carcasses.

Animal category

- Good classification performance was obtained for young cattle, yearlings and suckler animals.
- The best models achieved balanced accuracy values of up to 0.94 for young cattle.
- Abattoir-based models achieved excellent discrimination between yearlings and young cattle.

Housing system

- NIR models successfully differentiated indoor and outdoor production systems, with balanced accuracy reaching 0.80 in laboratory conditions and 0.73 in abattoir conditions.

Production cycle

- Models were able to distinguish fattening and suckler systems with moderate accuracy, reaching balanced accuracy values of approximately 0.74.

Genetic production type

- Discrimination between beef, dairy and mixed production types was more challenging.
- Prediction performance was lower than for country of origin and animal category, indicating a need for larger and more balanced datasets.

Practical recommendations

Beef processors, certification bodies, retailers and quality-control laboratories can use NIR spectroscopy as a rapid screening tool to verify some production claims and support traceability systems. Portable devices can be applied directly in slaughterhouses and processing plants, allowing authentication to be performed close to the production line without disrupting normal operations.

Limitations and future opportunities

Some production attributes, particularly genetic production type, were more difficult to predict because of overlap between groups and data imbalance. Results showed that model performance improves when datasets are balanced and when characteristics generate clear biochemical differences in meat composition.

Future work should expand sample numbers, include additional production systems and combine NIR spectroscopy with complementary information sources. This would further improve the robustness and applicability of authentication tools across the European beef sector.

Benefits for practitioners

Implementation of NIR-based authentication systems can:

- Strengthen consumer confidence in beef products.
- Support quality labels and certification schemes.
- Improve transparency throughout the beef supply chain.
- Reduce the risk of fraud and mislabelling.
- Provide rapid results without laboratory reagents or complex sample preparation.
- Enable real-time decision-making in slaughterhouses and processing facilities.

Key message

NIR spectroscopy is a practical, rapid and non-destructive technology that can authenticate important beef production characteristics, including country of origin, animal category and housing system. Portable devices can be used directly in abattoirs, offering a realistic pathway to strengthen traceability, support certification schemes and increase consumer trust in beef products.