First implementation of Rapid Evaporative Ionisation Mass Spectrometry (REIMS) for the at-line screening of boar carcasses in the slaughterhouse

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Introduction

Increasing awareness of animal welfare led to a European Treaty announcing a voluntary ban on the surgical castration of piglets by 2018. An alternative for surgical castration is the rearing of entire males, however, a disadvantage is the possible occurrence of boar taint, an off-odour caused by the release of androstenone (AEON), skatole (SK) and indole (IND) when boar meat is heated[1]. To date, surgical castration has not been widely abandoned by the pig industry due to the lack of viable mitigation strategies to prevent adverse consumer reactions including rapid detection methods for boar taint at slaughterhouses. Further to the study published in 2017[2], we report the implementation of REIMS-based fingerprinting method for at-line carcass screening in an abattoir environment.

Methods

Rapid Evaporative Ionization Mass Spectrometry (REIMS) was used as a direct analysis technique to train predictive models for high-throughput identification of boar taint above the odour threshold using adipose tissue sampled from the neck and back region of pig carcasses. Adipose tissue was sampled using a prototype bipolar handheld sampling device connected directly to a Xevo G2-XS Q-TOF mass spectrometer equipped with REIMS source (Waters Corporation, Manchester, UK). Untargeted mass spectrometric profiling in negative ionisation mode enabled the construction of predictive models using various packages (SIMCA, LiveID v1.2 and AMX) for the rapid classification of whole carcasses at line.

At-line performance of the instrument and predictive accuracy was evaluated in a slaughterhouse where carcasses were sampled c. every 10 seconds.

Preliminary Data

During the laboratory phase, 2058 boar fat samples were collected from two slaughterhouses in Belgium. Fat samples were sensorically scored by at least two independent experts using the soldering iron method with scores ranging from 0-4 (0=untainted to 4=strongly tainted). Chemical analysis was performed using UHPLC-HRMS for the detection of indole, skatole and androstenone[3]. For the purposes of model training, samples were classified as “tainted” when the fat levels of indole, skatole and/or androstenone exceeded 100, 200 and/or 1000 µg kg^{-1}regardless of the sensory score. Only samples with an average sensory score of 0 and levels of indole, skatole and androstenone below 50, 100 and 500 were classified as “untainted”. Samples giving conflicting results were excluded, leaving 1097 samples which included 93 “tainted”. Prior to modelling, all spectra were normalised using Total Ion Count (TIC), subject to logarithmic transformation and pareto scaling. Different models were constructed and well discriminating models were defined as R^2X, R^2Y, Q^2 having threshold values of 0.5 (aiming for a value of 1). Successful validation of the model required a p-value of <0.05 and unambiguous permutation test. A balanced model based on a

wide selection of discriminatory bins (n=98) offered the best predictive accuracy. The model training phase was repeated using the REIMS platform in the slaughterhouse with 554 samples from different production standards demonstrating the results from the laboratory phase could be replicated *in situ*.

The results obtained demonstrate that tainted carcasses can be correctly classified by an untargeted AIMS approach. The discrimination originates from alterations in lipid profiles. As REIMS eliminates sample pre-treatment, analysis takes <10 seconds, it offers potential as the first technique enabling *in-situ* detection of boar taint combined with accurate classification. REIMS is a promising tool for other applications in food quality, whereby rapid classification is requisite.

Novel Aspect

First demonstration of an at-line screening method for the classification of porcine carcasses generating results within 10 seconds.

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