INTRODUCTION

Increasing awareness on animal welfare led to a voluntary intent among European Member States to abandon the surgical castration of pigs by 2018. However, rearing entire males, one of the alternatives, implies the possible occurrence of boar taint in carcasses. Boar taint is an off-flavour, provoking negative consumer reactions, and consequently leads to severe economic losses in pig husbandry. For this reason, it is crucial to detect boar taint containing carcasses in a timescale compatible with at-line operation in the slaughter line.

One of the main challenges for the detection of boar taint at the slaughter line is the high rate of which pigs are slaughtered, on average 600 per hour. Over the past years, several candidate methods for at-line detection of boar taint have been proposed, including sensory and analytical methods. At present, accurate and fast analysis methods at the slaughter line are lacking. Rapid Evaporative Ionization Mass Spectrometry (REIMS) was evaluated for the latter purpose.

REIMS was originally intended for in vivo identification of tissues during medical interventions, but recently it has also found its application niche in food analysis as its feasibility was successfully demonstrated for the identification of the species of origin in meat products.

METHODS AND MATERIALS

Samples

Sow and boar neck fat samples were collected at the slaughter line (n=150). The presence or absence of boar taint in the samples was confirmed by sensory evaluation and UHPLC-HR-Orbitrap-MS analysis1. Samples containing levels of indole (IND), skatole (SK) and androstenone (AEDN) above and below the odour thresholds (IND: 100 µg kg⁻¹; SK: 200 µg kg⁻¹; AEDN: 500 µg kg⁻¹) were considered as positive and negative for presence of boar taint in neck fat

Samples putting forth the results revealed 46% of the samples as positive and 54% as negative for boar taint.

Sampling was carried out for 3 to 5 seconds with an iKnife hand-held sampling device (Waters, Wilmslow, UK), which was directly coupled to a Xevo G2-XS Q-TOF instrument equipped with a helical celled ribbon collision surface supplied with a constant current power supply set to 4.5 A (Kanthal D 1.0×0.1 mm).

RESULTS

Predictive OPLS-DA model

Evaluation of the obtained OPLS-DA model showed good validation characteristics (R²Y = 0.872, Q²Y = 0.756), indicating a good fit and predictive properties of the model. CV-ANOVA analysis (p<0.001) and permutation testing (20 permutations) confirmed the reliability of the obtained OPLS-DA model. A total classification accuracy of 99% was achieved.

Candidate discriminating compounds

In total, 60 ions demonstrated a high contribution to the classification (stratified 5 fold) results. Consequently, in order to correctly classify between tainted and untainted boar carcasses, the complete mass spectrum should be taken into account.

The model was challenged using porcine fat samples supplied by an independent source. The model was tested on samples from 5 different suppliers providing boar and sow neck fat samples. The model achieved a classification accuracy of 99% on the independent fat samples, guaranteeing the robustness of the model.

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Mass spectral fingerprint

Spectral differences between the three groups were mainly situated in the phospholipid and fatty acid region. MUFAs were predominantly present in the boar taint positive group. PUFA and SFAs were most abundant in the 2 boar groups compared to sows.

Heat map visualizing a selected number of putatively identified compounds in blank (sow) (n=50), positive (tainted) (n=50) and negative (untainted) (n=50) neck fat samples, with hierarchical clustering of the different samples.

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CONCLUSIONS

In this study, REIMS was able to correctly (99% accuracy) identify tainted boar neck fat samples within a couple of seconds, based on an untargeted profiling approach. The discrimination between boars (tainted & untainted) and sows originated from alterations in lipid profiles, mainly situated in the fatty acid and phospholipid region. Moreover, as REIMS enables in-situ analysis, guaranteeing point-of-control monitoring, it is a very promising and powerful tool for a diverse range of applications in food safety and quality.