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Non-inferiority testing for product development: A case study on boar tainted meat (#261)

Johanna Mörlein[1], Jan Gertheiss[2], Lisa Meier-Dinkel[3], Wolfram Schnäckel[4], Daniel Mörlein[1], The project is supported by funds of the Federal Ministry of Food and Agriculture (BMEL) based on a decision of the Parliament of the Federal Republic of Germany via the Federal Office for Agriculture and Food (BLE) under the innovation support program (FKZ 11OE143).

[1] University of Göttingen, Department of Animal Science, Göttingen, Germany; [2] Helmut Schmidt University, Department of Economics and Social Sciences, Hamburg, Germany; [3] isi GmbH, Rosdorf, Germany; [4] Anhalt University of Applied Sciences, Bernburg, Germany

Introduction

Sensory consumer studies are often conducted to detect significant differences between various formulations. In some instances, however, the aim is to rather state similarity. That is, one wants to prove whether two formulations are virtually equivalent in terms of consumer acceptance. The case of boar tainted meat lends itself to such a question: Here, it is necessary to identify the level of boar tainted meat which can be used in a mixture which is not worse than the reference from castrates/sows and possibly have other benefits, specifically the elimination of castration. Therefore, we propose the so-called *non-inferiority* testing (Meyners, 2012) instead of deriving conclusions from significant differences only.

Methods

Specifically, we wanted to derive an upper limit of tainted boar meat that can be used for the production of *Frankfurters* which guarantees sufficiently similar consumer acceptance. While forming mixtures is a widely used approach for other raw materials in food industry, it has not yet been systematically analyzed for boar tainted meat. That is why we simultaneously studied four factors relevant for the production of emulsion-type sausages: percentage boar meat (skatole concentrations up to 0.3 µg/g, androstenone up to 3.8 µg/g in melted backfat), duration of traditional smoke and two concentration levels of two spices. 16 variants of *Frankfurters* were produced in two independent studies and evaluated by in total 211 consumers. A linear mixed effects model revealed that increased levels of boar tainted meat significantly reduced consumer acceptance which could not be compensated by increased smoke or spice levels. We then applied a non-inferiority test to identify the percentage that is not substantially worse than a reference from castrates/sows. As it is statistically impossible to prove equality, the concept of non-inferiority is characterized by defining an inferior product by setting a non-tolerable liking drop compared to a control product. It is then tested, whether the product of interest is significantly better than the inferior product. By defining a margin, one-sided confidence intervals for effects of boar percentage from the model above can be used to conclude non-inferiority: in case of an interval completely within the margin, products with corresponding boar percentage can be stated as being sufficiently similar to the control. We used -0.5 as margin of acceptable deterioration/liking drop. That is, we consider a product with a liking drop of 0.5 inferior to the control.

Results

Figure 1 illustrates the one-sided 95% confidence intervals (CI) of flavor and odor liking for tainted boar meat percentage in the formulation for both studies separately, and for the combined data. For both odor and flavor liking, the CI is within the margin of non-inferiority for products containing 33% heavily tainted material. Because the red line is not exceeded by the whiskers of the confidence band, i.e., products containing 33% boar meat are significantly better than the margin of acceptable deterioration. In other words, these products are considered non-inferior to the control. Hence, under the conditions of this study up to 33% heavily tainted boar meat can be used without compromising consumer acceptance. This holds under the assumption that an inferior product is characterized by a liking decrease of (at least) 0.5 points on a 9 point liking scale.

The *non-inferiority* approach allowed us to identify the percentage of tainted boar meat which is sufficiently equal in terms of acceptability. Such blending (mixing) is a widely used strategy to maintain a consistent quality despite of varying raw material. Discarding safe carcasses because of otherwise harmless taint is a highly questionable procedure that in terms of sustainable pork production urgently needs to be reconsidered and revised. Therefore, reliable solutions are needed for processing tainted boar meat into acceptable products. The scale dependent liking loss in this calculation can of course also be set stricter depending on the risk a processor/retailer is willing to take.

Conclusion

The proposed *non-inferiority* test supports the idea that up to 33% tainted boar raw material can be used in processed pork products such as *Frankfurters*.

[1] Meyners, M. (2012). *Food Quality and Preference*, *26*(2), 231–245.
[2] Mörlein, J., Meier-Dinkel, L., Gertheiss, J., Schnäckel, W., Mörlein, D. (2019): Meat Science 152 (2019) 65–72.

Notes

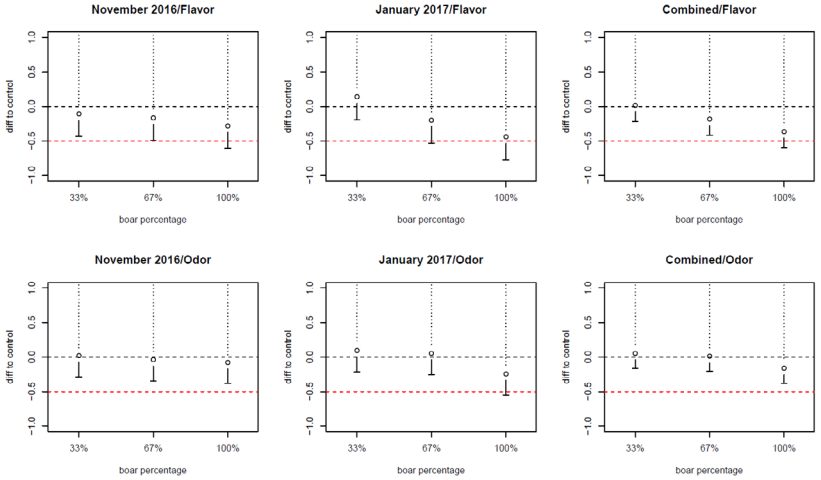

Figure 1: One-sided 95% confidence intervals of relative difference of consumer acceptance ratings f Figure 1: One-sided 95% confidence intervals of relative difference of consumer acceptance ratings for *Frankfurters* depending on the level of tainted boar meat as compared to formulations made from castrate meat. Results are given for both flavor and odor liking obtained in two independent studies with a total of 211 consumers. Liking was reported by consumers using a 9pt-scale ranging from 1 (dislike extremely) to 9 (like extremely). Red dotted line is the limit for non-inferiority (Mörlein et al., 2019).

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