Multivariate Analysis To Compare Pig Meat Quality Traits According To Breed And Rearing System

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Introduction

Pig meat quality depends on multiple interactive effects such as genetic background, rearing conditions, pre-slaughter handling, and carcass or meat processing. The biological characteristics leading to a high sensory quality are not clearly identified. Improving quality involves a better knowledge of the biological phenomena that govern the tissue characteristics and their impact on quality. The objective of this study was to analyze the between- and within- breed x rearing system variations considering a large amount of muscle and meat characteristics.

Material and methods

Fifty castrated pigs from Large White (LW) or Basque (B) breed were raised in an indoor (10 LW and 10 B), outdoor (10 LW and 10 B) or extensive (10 B) system, i.e. 5 classes of animals. They were slaughtered at 150 kg live weight in an experimental (indoor and outdoor pigs) or commercial (extensive B) slaughterhouse. A large set of variable was measured in the *Longissimus lumborum* muscle. These traits were divided in 9 groups: slaughter reactivity (plasma ACTH and cortisol), physical (pH, colour, drip loss, shear force), chemical (intramuscular fat, proteins, water), fatty acid composition, proteolysis and lipid oxidation (during meat ageing), muscle fibers (type and size), organoleptic (aspect and sensory evaluation), transcriptomics (15k Agilent muscle micro-array), and proteomics profiles.

Statistical analyses. We used multivariate analysis to integrate transcriptomics and proteomics data sets as well as scores of pig meat quality variables structured in modules. First, the overall pattern of correlations among traits was estimated using a Principal Component Analysis (PCA). Then, a between and within breed x rearing system PCA was conducted to assess which traits discriminated classes (between-class variability) and to identify structures that are common to all classes (within-class variability). To avoid the problem of structure differences between variables, we used the method of Multiple Factor Analysis (MFA; Escofier and Pagès (1994)) which consists in performing: 1/ a partial PCA for each class; 2/ an average PCA using the inverse of the largest eigenvalue of each partial PCA as weight. It is then possible to represent together the average and the five partial classes PCA by projection in a unique reference space, defined by the factorial axes of the

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average PCA. This approach was performed with the ADE4 package of the R software (Chessel, D., Dufour, A.B., and Thioulouse, J. (2004); Ihaka and Gentleman (1996)).

Results and discussion

The major part of variance (67%) was of within-class origin. The projection of the first 3 components of the between and within-class PCAs on the 3 first axes of the standard PCA of the whole data sets showed a strong correlation between the first components of the between-class PCA and the standard PCA. Conversely, the correlation between the first axes of the within-class PCA and the standard PCA was very low. The variables which discriminated the five classes were the same as those discriminating individuals. However, among classes, variables were differentially structured.

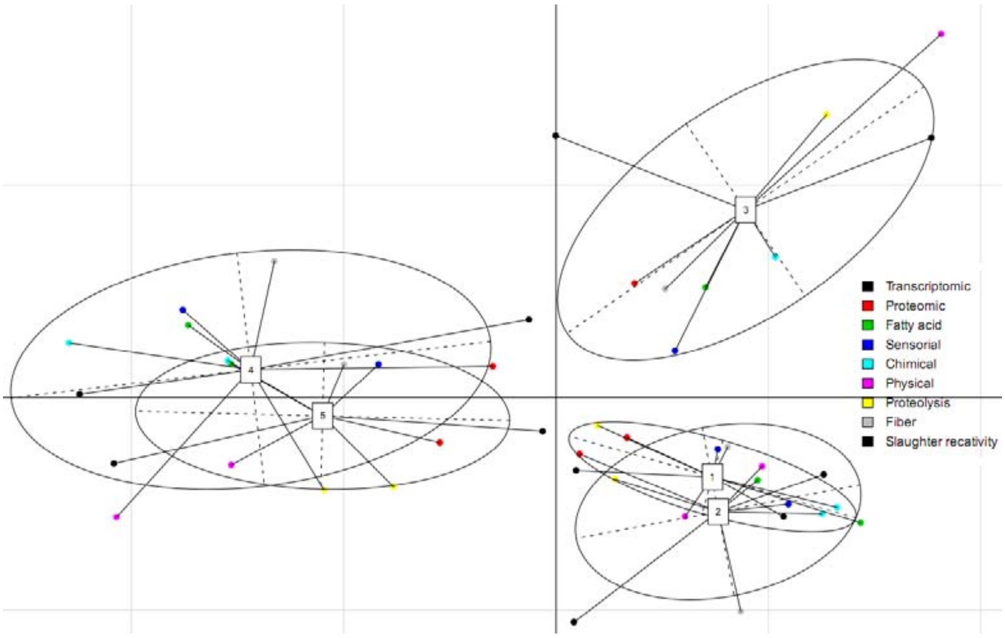

Figure 1: MFA scatterplot (Axis 1 and 2). Consensus and partial representations of breed x rearing system classes according to the nine variable groups (B indoor (1), B outdoor (2), B extensive (3), LW indoor (4), LW outdoor (5)).

Between-class structure. The first 2 components of the between-class PCA explained respectively 59.6% and 31% i.e. a total of 90.6% of the total variance between-class. Results of MFA analysis that allows a global comparison of the 5 classes showed that the first axis clearly discriminated breeds, and the second axis discriminated the rearing systems (figure 1). The first axis was primarily explained by transcriptomics data, chemical and physical measurements, and fatty acid composition. Slaughter reactivity, which mainly contributed to

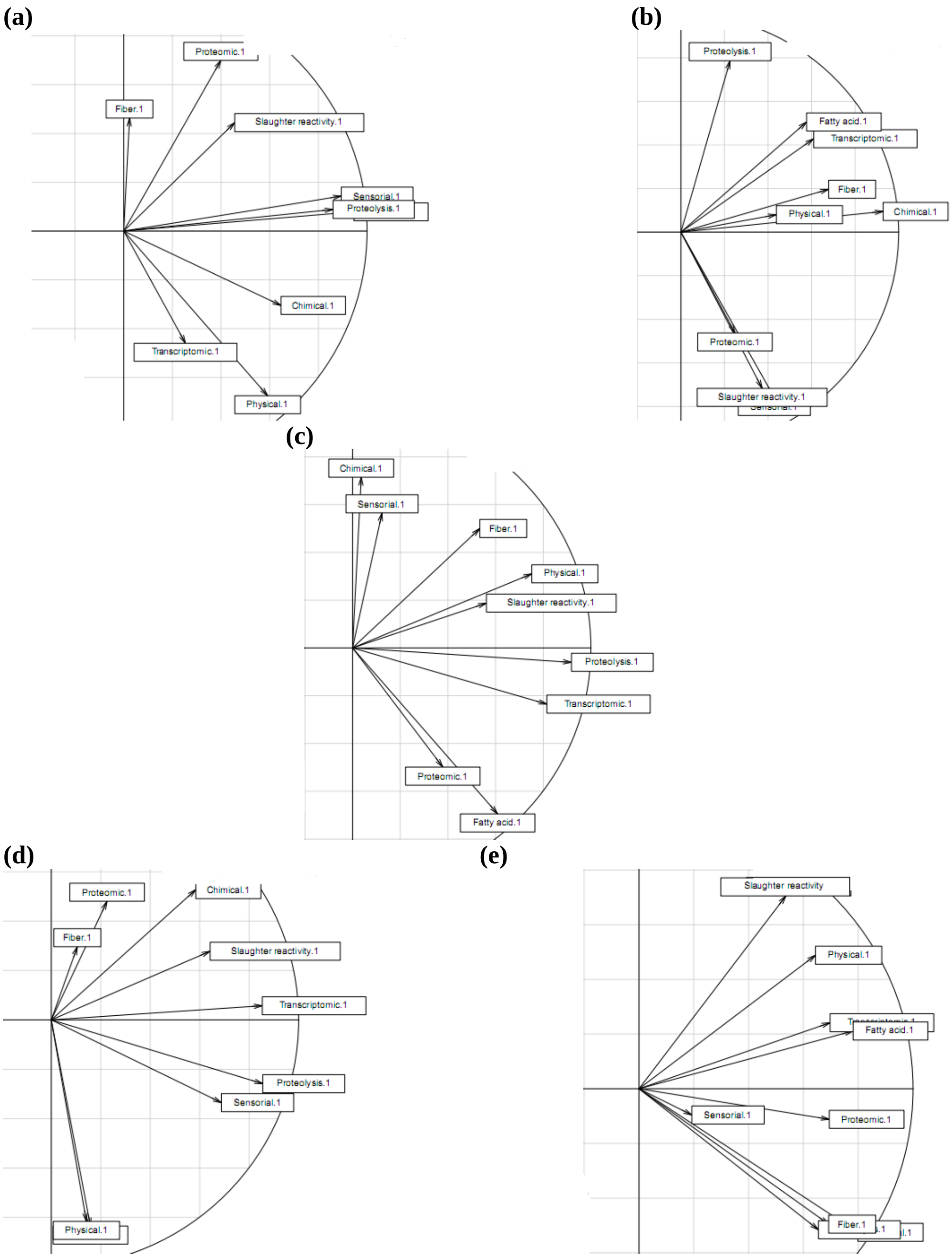

Figure 2: Overall pattern of correlations between the 9 groups of traits investigated, presented according to the 1-2 axes map for each within-class MFA variations: B indoor (a), B outdoor (b), B extensive (c), LW indoor (d), LW outdoor (e).

the second axis, was involved in the discrimination between rearing systems. Proteomic data were located near the origin, suggesting that they were of less importance for breed and rearing system discrimination. Three groups of variables: muscle fiber traits, proteolysis and sensory quality were located in an intermediate position according to their correlation with the 3 first axes of the MFA compromise.

Within-class structure. The MFA conducted within breed x rearing system classes showed that the group of chemical variables was the common component which was mainly explained on the first 2 axes of the MFA compromise of the five classes.

In the indoor system, correlations between variables within each breed were relatively similar (figures 2a and 2d). Indeed, chemical variables were strongly correlated with sensorial and proteolysis variables in both LW and B breeds. However, transcriptomics data were mainly explained on the first component in the B breed and on the second axis in the LW.

In the outdoor system, correlations between variable groups were different between breeds (figures 2b and 2e). Physical traits were of minor importance for B pigs discrimination, while, they were mainly correlated on the second axis in the LW. Conversely, sensorial variables were highly correlated with proteomics data and slaughter reactivity variables on the second axis for B pigs, but did not contributed to the discrimination between LW.

Regarding B extensive pigs, physical, proteolysis and transcriptomics variables highly contributed to discrimination between individuals (First axis of MFA), followed by chemical and fatty acid variables (second axis). Sensorial variables were of less importance in the discrimination between individuals in this class, compared with B indoor and B outdoor pigs in a lower extent (figure 2c).

The importance of physical variables in discriminating B extensive pigs can be explained by differences in pre-slaughtering conditions (transport, lairage in slaughterhouse,…) between extensive B and the 4 other groups despite our efforts to «standardize» pre-slaughter handling between experimental and commercial slaughtering.

Conclusion

Present results demonstrate that the multivariate analysis can be of great interest to overview the differences between breeds and rearing systems, for a very large number of traits covering a variety of muscle and meat characteristics. It is also helpful to highlight the relationships between different kinds of data sets.

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