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TOWARDS A 'ONE QUALITY' APPROACH INTEGRATING INTRINSIC AND EXTRINSIC PORK QUALITY DIMENSIONS TO FOSTER THE SUSTAINABILITY OF PORK PRODUCTION: A STUDY COMBINING PIG GENETICS AND FEEDING STRATEGIES

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I. INTRODUCTION

Meat quality, including pork quality, is a multidimensional concept encompassing both intrinsic and extrinsic dimensions, which together shape the perception and evaluation of fresh pork [1]. Intrinsic dimensions are inherent to the product (product-related) and include sensory, nutritional, technological, sanitary, commercial, and convenience properties [2]. In contrast, extrinsic dimensions refer to the perceptions on how pork is produced (production-related) and can be either objective (*e.g.,* environmental impacts, welfare indicators) or subjective (*e.g.,* brand, farming conditions). In the recent years, extrinsic dimensions have gained increasing importance in consumer perceptions and purchasing decisions [3]. Despite this growing interest, there is a scarcity in studies that have simultaneously integrated the intrinsic and extrinsic pork quality dimensions. To address this gap, we recently introduced the 'One Quality' concept [1], which promotes a holistic approach along the value chain by jointly considering both quality dimensions, and enhancing their mutual value within the framework of sustainable production and consumption of pork. This study is therefore aligned with the 'One Quality' concept, aiming to assess the joint effects of pig genetics and feeding strategy on multiple intrinsic (commercial, technological, sensory and nutritional) and extrinsic (environmental impacts) pork properties and their integration using multidimensional analysis.

II. MATERIALS AND METHODS

The trial involved 60 female pigs from two genotypes: [LW × LD] × Piétrain NN (**P**) or [LW × LD] × Duroc (**D**), raised under two distinct feeding strategies [4]. At an average body weight (BW) of 33 kg, pigs were allocated into 4 experimental groups (n=15/group): PC and DC received a control diet (**C**) based on oilseed meals (imported soybean, rapeseed and shelled sunflower), while PR and DR were fed an **R** diet containing extruded faba bean (locally sourced) as the main protein source and extruded linseed as a source of n-3 polyunsaturated fatty acids. All pigs were housed individually and fed *ad libitum* until slaughter at ~116 kg BW [4]. The effects of genotype and feeding strategy and their interaction on various intrinsic and extrinsic pork attributes were evaluated using an ANOVA. From a broader study [4], this abstract focuses on certain intrinsic pork properties including **i) commercial properties:** lean meat content (%), carcass dressing (%), hot carcass weight (kg), final (slaughter) BW (kg), feed efficiency, average daily gain (g) and average daily feed intake (ADFI); **ii) technological properties:** drip loss (%), pH24h and glycolytic potential; **iii) sensory properties:** tenderness, juiciness and flavor scores, and marbling of raw pork evaluated by trained panelists and intramuscular fat (IMF, %); **iv) nutritional properties:** C18:2 n-6:C18:3 n-3 and SFA:n-3. The extrinsic pork quality included the **environmental impacts** assessed by a cradle-to-farm gate individual life cycle assessment (LCA). The MEANS-InOut web software was used to generate the life cycle inventories [5]. Then, an adapted Environmental Footprint 3.0 characterization method in SimaPro® 9.5 generated the individual LCA data (16 impact categories) associated to the production of 1 kg BW pig. Based on the most assessed impact categories in pig, 8 were used: climate change (CC), acidification potential (AP), resource use (RU), water use (WU), land use (LU), and terrestrial (ET) and freshwater (EF) eutrophication. Finally, intrinsic quality properties were integrated with the environmental impact categories after data normalization (Z-scores) through principal component analysis (PCA).

III. RESULTS AND DISCUSSION

The PCA explained 60% of the total variance, with the PC1 alone accounting for 46.3% (Figure 1A). The bi-plot (insert at the bottom left of the PCA) showed a clear separation between P and D genotypes, and between feeding strategies within each genotype. Most quality traits relevant to the commercial properties were projected on the negative side of PC1, indicating lower values in D compared to P pigs, further confirmed by the variance analysis results (summarized in Figure 1B). R diet further improved the commercial pork properties than C diet (Figure 1B). Technological and sensory properties were influenced solely by genotype, with higher values observed in D than in P pigs (Figure 1B). Nutritional properties were affected by both genotype and feeding strategy, being higher in D than P pigs and significantly enhanced by the R diet compared to C [4]. Environmental impacts were influenced by both genotype and feeding strategy, although the type and degree of effect varied depending on the impact category.

Overall, D pigs exhibited higher (*i.e.,* worse) environmental impacts than P pigs, and impacts were greater with the C than the locally sourced R diet. Specifically, CC, AP, RU and WU were influenced by both genotype and feeding strategy (Figure 1B). In contrast, ET and LU were affected only by genotype, while EF was influenced only by feeding strategy. Interestingly, on the PCA (Figure 1A), the high environmental impacts projected on the positive side of PC1 were accompanied by higher n-6:n-3 and SFA:n-3 ratios (lower nutritional property). These associations between environmental impacts and nutritional metrics highlight the interest of developing nutritional LCA (n-LCA), integrating both sustainability and health-related dimensions of meat production [6]. Moreover, greater average daily feed intake (ADFI, commercial property) were linked with higher environmental impacts, mainly for DC compared to PR, depicting trade-offs within pork quality properties. The results further revealed synergies between intrinsic and extrinsic pork dimensions, that were enhanced through combined breeding and feeding strategies (PR).

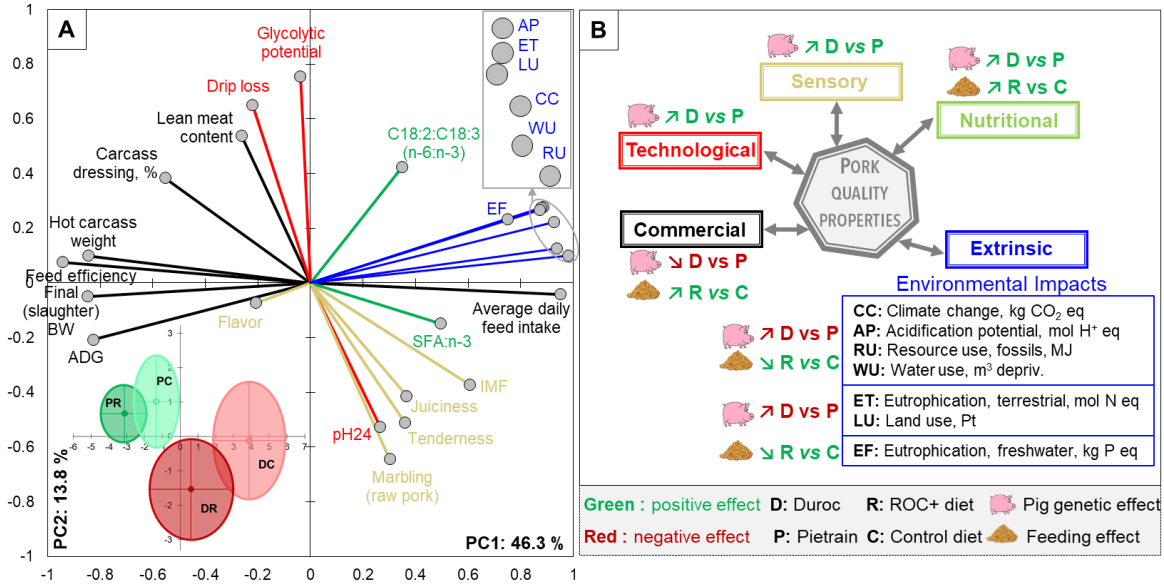


Figure 1. **A)** Multidimensional analysis using principal component analysis integrating after data normalization the intrinsic pork quality dimensions with the environmental impacts. **B)** Summary of the main ANOVA effects of genotype and feeding strategy on the multiple pork quality properties.

IV. CONCLUSION

Thanks to the use of individual-level data on both intrinsic and extrinsic pork quality dimensions, the multidimensional analysis enabled their integrated assessment, providing a deeper understanding of the complex interactions between pork properties involved in sustainable pork production. This integrated approach highlighted key trade-offs and synergies among pork properties, that can be modulated by genotype and feeding strategy. The findings support that optimized strategies at farm level can enhance both intrinsic pork quality and environmental performance, ultimately contributing to more sustainable pork production and consumption and thereby fostering the implementation of the 'One Quality' concept.

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