Pork quality differences between lines divergently selected for residual feed intake

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Abstract— **Recent studies demonstrated that a selection for residual feed intake (RFI) led to improved feed conversion ratio and carcass lean meat content. However, the understanding of the relationships between RFI and pork quality is still unclear and deserves further study to meet producer, processing industry and consumer demands. Our objective was to evaluate the impact of a divergent selection on RFI on technological and sensory quality of meat. After six generations of selection, growth performance, carcass composition, muscle biochemical and meat quality traits were studied in 117 Large White females and castrated males from two divergent RFI lines fed *ad libitum*. Despite similar growth rate, the low RFI line (RFI-) pigs were more efficient (p<0.001), exhibited leaner carcasses (p<0.001) and a greater carcass yield (p<0.001) than high RFI line (RFI+) pigs. Selection for low RFI affected meat quality parameters by increasing muscle glycogen content (p<0.001) as well as the extent of pH decline (p<0.001) and drip loss (p<0.001), and decreasing IMF content (p<0.001) in the *Longissimus* muscle. Visual appearance of fresh meat was also influenced, with lower scores for marbling, homogeneity and intensity of red color of the RFI- pork. However, these differences between RFI lines had no effect on meat tenderness and juiciness. Regarding trade-offs between economical results for producers (lower feeding cost, higher carcass lean content) and environmental issues, the negative impact of selection for low RFI on pork quality could be moderated.**

Keywords— **Residual Feed Intake, selection, pork quality**

I. INTRODUCTION

Animal breeding for sustainable production systems has to be organised to produce meat as efficiently as possible by maintaining productivity, improving utilization of feed and reducing environmental impact [1]. Selection for a low residual feed intake (RFI) is considered as a relevant way to improve efficiency of animal production [2-3]. At similar growth rate, pigs from the efficient line (RFI-) have leaner carcass, higher muscle glycogen content and lower ultimate pH than pigs from the "luxurious" line (RFI+) [3]. Effects of selection for improving lean tissue deposition on muscle metabolism confirm unfavourable genetic correlations reported between global pork quality and feed conversion efficiency [2-4]. However, the understanding of the relationships between RFI and pork quality is still unclear and deserves further study to meet producer, processing industry and consumer demands. Our objective was to evaluate the impact of a divergent selection on RFI in pigs, on technological and sensory quality of meat after six generations of selection.

II. MATERIALS AND METHODS

A. Rearing and slaughtering

A total of 117 Large White (LW) females and castrated males pigs, 60 RFI- and 57 RFI+, were fed *ad libitum* and controlled individually during the growing-finishing period (31±5 up to 108±8 kg) for body weight and daily feed consumption. The experimental growing diet was composed of 16% protein, 0.47% phosphorus, and 0.72% potassium and provided 9.7 MJ/kg of net energy. At an average of 108 kg body weight, after approximately 24h fasting, pigs were slaughtered by electrical stunning and exsanguination, under highly standardized slaughtering conditions.

B. Carcass traits

The day of slaughter, hot carcasses were weighted. After 24h at 4°C, weights of fresh carcass and wholesale cuts (ham, loin, backfat) were recorded.

Lean meat content was then estimated from the percentage of primal cuts [5]. Carcass dressing percentage and body composition were calculated.

C. Meat quality of loin

1. Physico-chemical properties

Thirty minutes post-mortem, *Longissimus* muscle (LM) samples were collected, frozen in liquid nitrogen and stored at -80°C until determination of glycolytic potential (GP) and the rate of pH decline (pH1). The following day, ultimate pH (pHu) was directly measured on the carcass, meat colour (Lightness L*, redness a*, yellowness b*) was determined after 1h30 blooming under artificial light, and a LM slice was taken, minced and freeze-dried before determination of intramuscular fat content (IMF). Drip loss was evaluated at 4 days post-mortem [6].

2. Sensory traits

After 4 days ageing, loin samples were vacuum-packed and stored at -20°C until sensory analyses. A 12-members trained taste panel assessed homogeneity and intensity of red colour as well as marbling of raw meat. After cooking in an oven to an internal temperature of 80°C, roasts slices were assessed for odour, tenderness, juiciness and global flavour. Scores were given on a scale from 0 (absent) to 10 (high).

3. Statistical analyses

All statistical models included selected line as fixed effect and were submitted to an analysis of variance (GLM procedure, Statistical Analysis System (SAS) Institute, 1989).

D. Environmental impact

Excretions in effluents and retentions of nitrogen and phosphorus were estimated using the French CORPEN method [7]. It was based on calculating differences between inputs (animal, feed) and outputs (animal, losses) at the pig barn level. Body retention and excretion were estimated for an average pig from each line based on animal growth (body weight, lean meat content), and feed utilization (consumed and retained quantities) and composition (protein and minerals).

Table 1 Carcass traits

	RFI+ line	RFI- line	P-value
Empty body weight, kg	107.9	109.9	NS
Hot carcass weight, kg	83.0	86.3	*
Dressing, %	78.6	80.0	***
LMC, %	57.5	58.7	***
Ham, %	24.5	24.6	NS
Loin, %	27.2	28	**
Backfat, %	7.6	6.7	***

Table 2 Loin traits

	RFI+ line	RFI- line	P-value
pH1	6.42	6.38	NS
pHu	5.68	5.59	***
Drip loss, %	2.7	3.8	***
L*	51.5	52.7	*
a*	8.11	8.66	*
b*	5.03	5.59	*
GP, µmol/g	132	144	**
IMF, %	1.39	1.17	***

III. RESULTS AND DISCUSSION

The divergent selection for low RFI reduced feed consumption (-219 g/d, p<0.001), while preserving growth performance (Average Daily Gain=760 g/d, p=0.92), and thus improved feed efficiency of pigs (-0.3 kg/kg for Feed Conversion Ratio, p<0.001). At similar slaughter weight, selection influenced body composition. RFI- carcasses exhibited a lower adiposity, due to higher percentage of loin and lean meat content (+1.8 points), and a lower backfat proportion (Table 1).

Nevertheless, selection for low RFI affected some meat quality traits (Table 2). In RFI- loin, a significantly higher GP was correlated (r=-0.20, p=0.03) with a higher extend of pH decline (p<0.001). The pH1 was not influenced by divergent selection (p=0.22), but RFI- pigs had higher drip loss which was positively correlated with L* value (r=0.33, p<0.001).The a* (redness) and b* (yellowness) values were slightly higher in the more efficient RFI- line. Selection for low RFI also induced a significantly lower IMF content in the LM (p<0.001), which was in compliance with their lower carcass fatness. Overall, the lower ultimate pH and IMF combined with the higher drip loss suggest a negative impact of divergent selection on technological and some sensory meat quality traits in the efficient RFI- pigs.

Sensory analysis data reported in Figure 1 denote an impact of divergent selection on fresh meat appearance, but only a slight effect on sensory quality of cooked LM. Intensity and homogeneity of red colour and marbling were higher in the RFI+ line pigs, whereas no significant differences between lines were noticed for tenderness, juiciness and global flavor of loin.

Overall, low RFI pigs exhibited higher lean meat content and impaired meat technological quality, whereas sensory quality of cooked meat was not affected. In the efficient RFI- pigs, the increased LM glycogen content increased the capacity for postmortem glycolysis, which extended the pH decline and influenced the conversion of muscle into meat. However, the mechanisms contributing to the higher LM glycogen content and its consequences on post-mortem muscle metabolism and subsequent meat quality in the RFI- pigs remain unclear. Further research is still needed to relate feed efficiency, muscle energy metabolism, and meat quality. The possible involvement of the AMPK pathway in these relationships is presently investigated.

As far as the producers, the processing industry, the consumers and citizens are concerned, the advantages for selecting efficient- low RFI pigs may be conflicting, depending on the actors along the pork production chain. A comparative approach has thus been developed to evaluate the environmental impacts of divergent selection for RFI. Our results indicate that decreasing RFI would have a favourable environmental impact by reducing nitrogen (-4 pts) and phosphorus (-5 pts) percentage of excretions, and by improving nitrogen (+4 pts) and phosphorus (+5 pts) percentage of retentions.

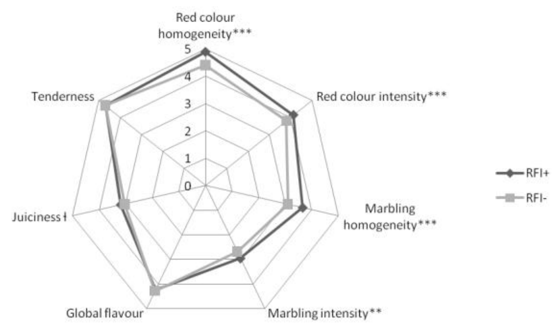

Figure 1 : Sensory quality of loin

IV. CONCLUSIONS

Despite a significant impairment of some technological and visual traits of raw meat, as well as a lower IMF content, the divergent selection for a low RFI remains a promising way to reduce feeding cost and the environmental impact of pig production, while improving lean meat content of the carcass. Nevertheless, a global evaluation of the impact of pork quality differences between lines should be undertaken, in particular through semieconomic approaches taking into account non market (social concerns) and market (profit or costs) economic traits values, together with the respective interests of farmers, processing industries, consumers and citizens.

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