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Does genetic selection for feed efficiency make pigs more susceptible to production diseases?

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Results of three experimental studies conducted by PROHEALTH

A set of experiments of PROHEALTH was designed to investigate a hypothesis about genetic selection in pigs that has been repeatedly formulated, but so far was lacking scientific evidence: It was hypothesized that improved productive traits (e.g. growing fast or using feed efficiently) are gained at the expense of reduced robustness, i.e. reduced capacity of the animal to be in good health and to maintain its performance in suboptimal environments. The reasoning behind this hypothesis is that selection for productive traits might impact the metabolism of the animal in a way that nutrients are increasingly used for productive functions (growth and protein deposition) and less for non-productive functions such as stress and defence responses.

Investigating the effects of selection for feed efficiency

PROHEALTH experiments compared two lines of pigs selected for residual feed intake (RFI), which is a measure of the efficiency of the conversion of feed to meat. RFI corresponds to the difference between the actual observed and the predicted feed intake. Pigs with a high-RFI eat more than predicted and are thus less efficient at converting the feed to meat than pigs with a low-RFI. These two lines are an interesting model to determine the consequences of genetic selection on animal physiology and health.

Three trials were conducted under controlled conditions to evaluate low-RFI and high-RFI line susceptibility to: 1) weaning stress, with special emphasis on digestive disorders, such as postweaning diarrhoea; 2) leg disorders, lameness and osteochondrosis occurrence when pigs are housed on concrete floors; 3) respiratory and inflammatory diseases, such as pneumonia caused by poor hygiene of the housing conditions. Pig characteristics measured included individual growth rate and feed intake, behaviour, health, compositions of blood, organs, tissues and carcass at slaughter, as well as meat quality.

Trial 1: Piglet health during weaning stress

In pig farms, piglets are usually separated from the sow at a young age (3 to 4 weeks of age). This early weaning is a stressful and critical phase for pig production, because of the relative piglet immaturity and the stress caused by the weaning (e.g. separation from the sow, new feed, and new environment). Antibiotic treatments are still commonly used after weaning to control digestive diseases that often occur after weaning. The genetic background is suspected to influence piglet health at weaning, but it remains poorly documented. Piglets from both RFI lines were weaned at 28 days of age and individually assessed for growth rate and health characteristics for five weeks after weaning. Piglets from the low-RFI line were more affected by weaning than piglets from the high-RFI line. In the first week after weaning, they ate and grew less (Figure 1), had more diarrhoea and a higher inflammatory status. However, they recovered during the second and third weeks and both lines had similar performance and physiological characteristics at the end of the post-weaning period.

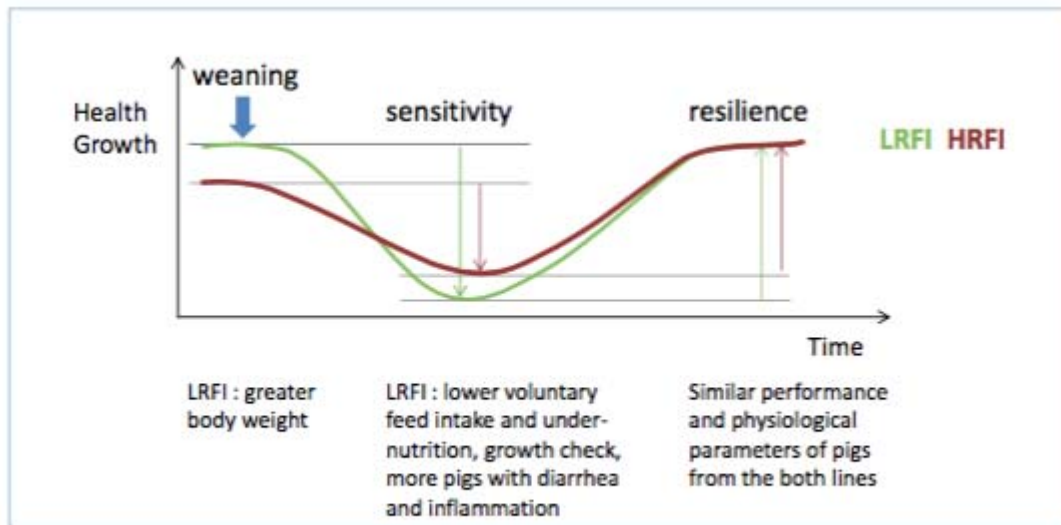


Figure 1. Dynamic of the response of the RFI lines after weaning

Trial 2: Housing large groups of pigs on concrete floors

Locomotory disorders, and more specifically lameness, have been identified as one of the significant production diseases for growing- finishing pigs and sows. Lameness is a complex problem with multifactorial causes. Among these causes, osteochondrosis has a very high prevalence in all common pig breeds. Osteochondrosis is a local failure of blood circulation at the top of long bones that causes cracks of joint cartilage (Figure 2). However, the proportion of lameness that can be linked to osteochondrosis is difficult to evaluate and is still unknown. Pigs from high and low RFI lines were housed on concrete floors in a room equipped with an electronic weighting device allowing pigs access to electronic self-feeders. Measurements were collected throughout the growing- finishing period for behavioural activity, lameness, osteochondrosis lesions, and growth rates. The study confirmed the high prevalence (55 to 90% of pigs depending on the joint) of osteochondrosis lesions during the growth period. Lesions were more frequently observed in low-RFI pigs - without any correlation with lameness, which affects a low proportion of pigs in both lines.

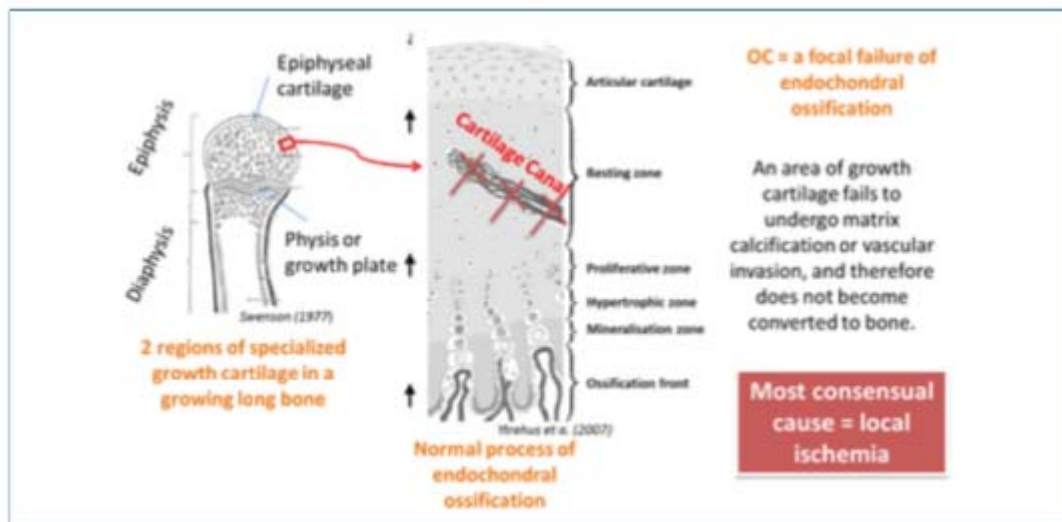


Figure 2. Process of osteochondrosis lesions

Trial 3: Hygienic conditions during the growing phase

Poor housing hygiene and the lack of respect of biosecurity rules are risk factors for pig health. Both low- RFI and high-RFI pigs were housed in either clean or dirty housing environments for the first six weeks of the growing phase (see Le Floch et al., 2014 for a description of the model). Prevalence of respiratory lesions at slaughter was higher in dirty conditions, including inflammation of lung tissue (pneumonia) or the surrounding membrane (pleurisy). The pig growth rate was on average 20% lower in dirty conditions, and this reduction was unexpectedly greater for the high-RFI line than the low- RFI line (26 vs 12%). Poor hygiene conditions induced a systemic inflammatory response (Figure 3) and oxidative stress, and this response was greater in high-RFI pigs, which is the opposite of the initial hypothesis. Meat quality evaluated at slaughter (seven weeks after all pigs were housed back in clean conditions) was not dramatically affected by poor hygiene during early growth, but body weight at slaughter was still lower for pigs having been reared in poor hygiene conditions (5.5 and 13.4 kg difference between clean and dirty for low-RFI and high-RFI, respectively).

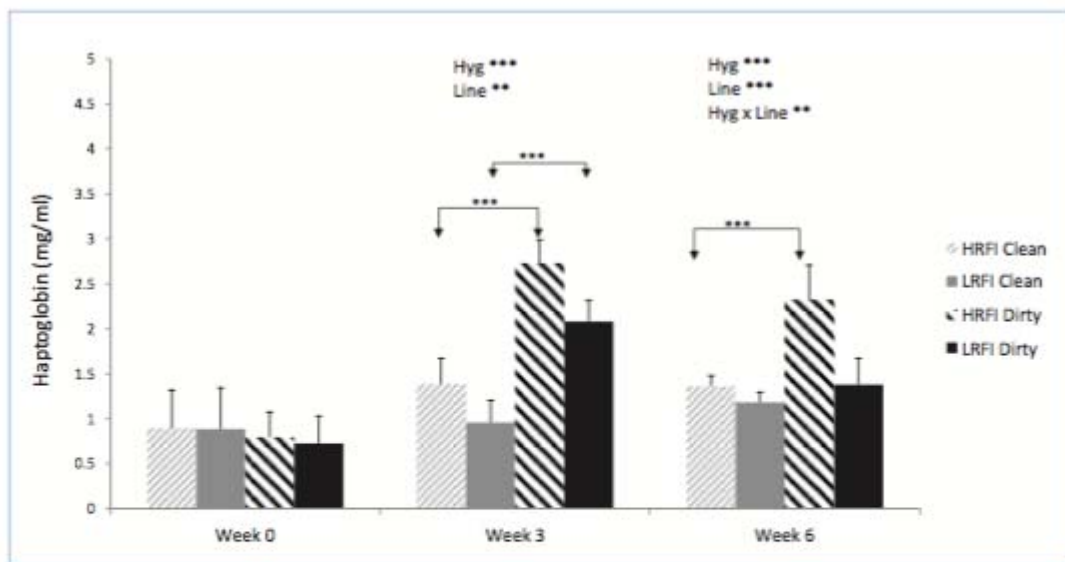


Figure 3. Consequences of the deterioration of environmental hygiene conditions on plasma haptoglobin concentrations (mg/ml) at Period 1 for the 4 experimental groups. During Period 1: C- HRFI – C-LRFI and D-HRFI or D-LRFI represented pigs housed either in good or poor hygiene with the less efficient (HRFI) and the most efficient (LRFI) line. Line: Line effect, Hyg: Hygiene effect Hyg x Line : interactions between Hygiene and Line. ** $P < 0.005$ and *** $P < 0.001$. Arrows under the bars indicate pairwise comparisons. Error bars are mean standard deviations of the back-transformed data calculated from predicted values.

Conclusions

Whilst various characteristics of the post-weaning response differ between RFI lines in the early stages of piglet weaning, no difference was observed by the end of the weaning period. Piglets from the low-RFI line were transiently more affected by undernutrition caused by the stress of weaning, but this could be overcome by tailored nutritional strategies. Poor hygiene conditions impacted pig health during the growing- finishing phase and pig weight at slaughter. Pigs from the high-RFI line were clearly more affected than the more efficient low-RFI pigs. These experimental studies indicate that selection of pigs for low RFI (high production efficiency) has no negative impact on the robustness, health and coping capacity of pigs by the end of the weaning period.

Source: Le Floc'h, N., Knudsen, C., Gidenne, T., Montagne, L., Merlot, E., Zemb, O. (2014). Impact of feed restriction on health, digestion and faecal microbiota of growing pigs housed in a good or poor hygiene conditions *Animal*, 8(10), 1–11. <http://doi.org/10.1017/S1751731114001608>.