Feed-a-Gene

Adapting the feed, the animal and the feeding techniques to improve the efficiency and sustainability of monogastric livestock production systems

Effects of birth weight and genetic capacity for protein deposition on N-efficiency in growing pigs

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INTRODUCTION

Low birth weight (LBW) piglets have a low number of muscle fibres at birth and eat and grow less during the weaning and growing period (Rehfeldt et al., 2008; Alvarenga et al., 2013) compared to littermates. Therefore, LBW piglets may show a lower performance, protein retention and nitrogen efficiency later in life. In addition, genomic information of pigs can provide information on the growth potential and protein deposition (PD) capacity of individual pigs. Quantitative data on the effects of birth weight and genetic capacity on body protein deposition and nitrogen efficiency, however, are scarce.

OBJECTIVES

The present study investigated the effects of birth weight (BiW) and genetic capacity for PD on nitrogen (N) digestion and N-utilization and selected blood parameters in growing pigs (50 - 80 kg).

MATERIALS AND METHODS

- The study was carried out in a 2 x 2 x 2 factorial design with BiW, genetic capacity for PD and dietary protein supply (adequate (100%) and restricted (70%)) as experimental factors.
- In total 40 male pigs, 20 with a low (< 1.2 kg) and 20 with a high (>1.6 kg) BiW balanced for litter were used. Within both groups piglets had either a high (mean +10 g/d) or a low (mean -2 g/d) genetic capacity for PD (BV), based on genome sequence information of individual pigs (Topigs Norsvin).
- Pigs were grown up under similar conditions till an age of 14 weeks before transportation to the experimental facilities where they were housed in metabolism cages for a period of 4 weeks.
- N-balance of pigs was determined via quantitative collection of faeces and urine over two subsequent periods of 5 days on a protein/AA adequate and a protein/AA restricted diet at a level of 2.8 x M. Blood samples from all pigs were taken at the end of each balance period for measurement of systemic parameters related to energy and protein metabolism.

- Pigs were fed a mash diet mixed with water (water : feed = 2:1) twice a day and were provided with ad libitum drinking water.
- N-adequate diet: 81.4% basal diet + 18.6% protein rich feedstuffs (casein, wheat gluten flour, potato protein, L-Lys HCL, L-Thr).
- Protein/AA level in the restricted diet was 30% lower than in the protein adequate diet (12.5 vs 16.6% CP) via restricting the inclusion of protein containing ingredients and free AA. Relative to their metabolic BW, the feed allowance of pigs assigned to the restricted regime was 94.4% of that of pigs receiving the adequate protein regime.
- Results were analysed via GLMM (GenStat) using the following model:

  y = μ + week + BW + PD + protein supply + sequence of diets + BW x PS + BW x PD + PD x PS + error
  - ➢ Week: balance week 1 vs. balance week 2
  - ➢ BiW : Birth weight: low vs. high
  - ➢ PD: low vs. high genetic capacity for PD
  - ➢ PS: Protein supply: adequate vs restricted protein supply
  - ➢ Sequence: adequate-restricted protein supply vs. restricted-adequate protein supply

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Feed-a-Gene is a European H2020 project involving 23 partners which aims to adapt feeds, animals and feeding techniques to improve the efficiency and sustainability of pig, poultry and rabbit production systems. The project aims to reduce the environmental impact of monogastric livestock production by improving and diversifying animal diets and feed technologies and by integrating new selection criteria for these animals. The Feed-a-gene project further aims to develop new management systems for precision feeding and precision farming and to evaluate the overall sustainability of the different management solutions proposed in the project.

RESULTS

Table 1. Breeding value for PD, birth weight and body weight of pigs used in the experiment.

	Birth weight		BV protein deposition		P-value		
	Low	High	Low	High	BW	BV	BW x BV
Breeding value (g/d)[1]	4.0	4.5	-2.3	10.8	0.65	<0.001	0.88
Birth weight (kg)	1.04	1.80	1.41	1.43	<0.001	0.53	0.58
Weight at day 0 (start adaptation)	49.0	59.9	54.3	54.6	<0.001	0.81	0.41
Weight at day 28 (end N balance 2)	69.8	83.3	77.0	76.1	<0.001	0.62	0.21

[1]relative to an pig average crossbred pig with a PD of 146 g/d

Figure 1. Effects of birth weight, genetic capacity to deposit protein and dietary protein supply on N-retention (g/d) and N-utilization (%). Interactions between main effects were largely absent.

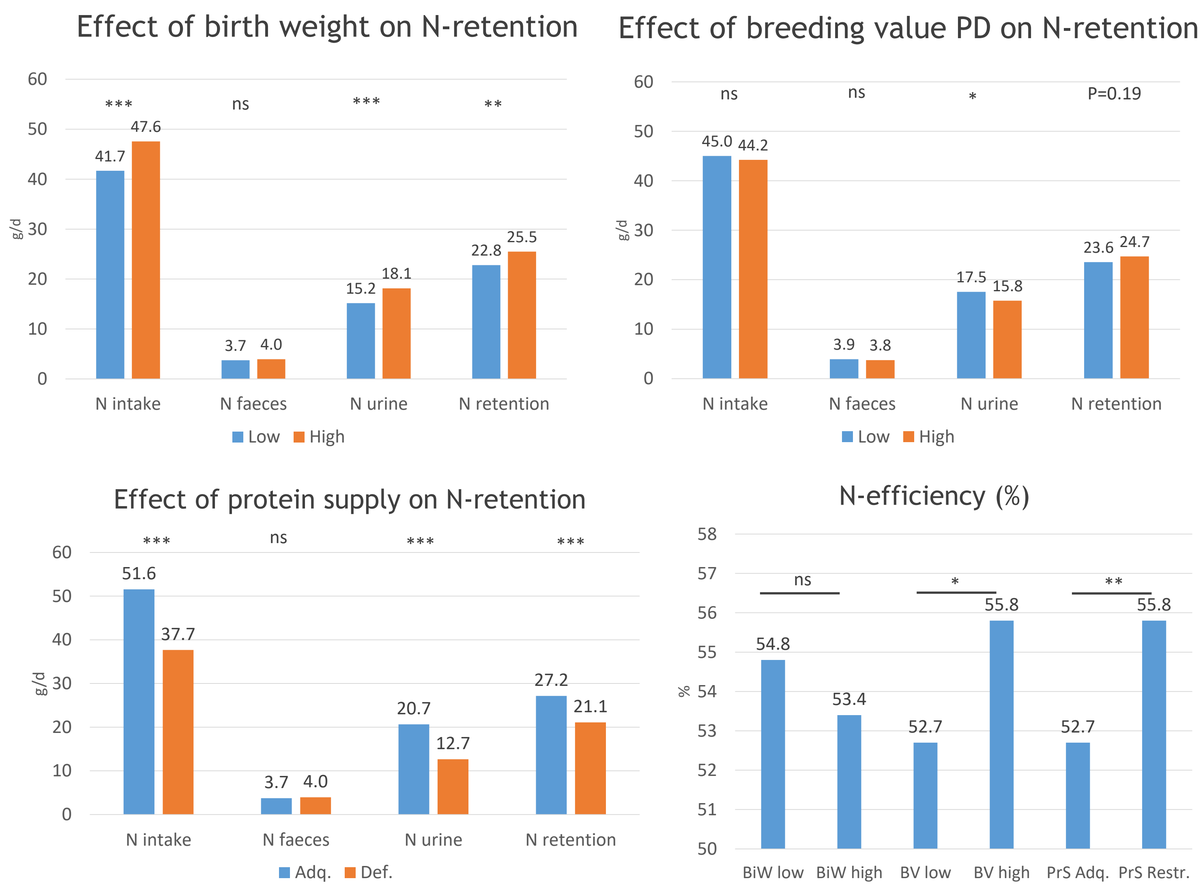

Table 2. Effects of birth weight and genetic capacity to deposit protein (BV) on various blood parameters.

	Birth weight		BV PD		P-value		
	Low	High	Low	High	BW	BV	BW x BV
Insulin, uU/ml	28.6	31.8	31.0	29.4	0.32	0.63	0.58
Glucose, mmol/l	6.43	5.90	6.02	6.31	<0.01	0.13	0.58
Urea, mmol/l	3.19	3.12	3.21	3.10	0.65	0.41	0.56
IGF-1, µg/l	184	195	182	197	0.46	0.32	0.78
α-amino N, mmol/l	7.37	7.37	7.45	7.29	1.00	0.42	0.90
Creatinine, µmol/l	95.7	96.2	90.3	101.5	0.88	<0.01	0.62

CONCLUSIONS

- Birth weight affects absolute N-retention but does not affect N-efficiency later in life. A high genetic capacity for PD reduces urinary N-excretion and improves N-efficiency in pigs.
- Birth weight and genetic capacity for PD do not affect apparent fecal digestibility of dry matter and N in the grower phase.
- Protein restriction reduces N-retention but slightly improves N-efficiency in growing pigs.
- Low birth weight piglets have a higher glucose level in blood, and blood creatinine level is higher in pigs with a high genetic capacity for PD, related to differences in post-absorptive energy and protein metabolism in pigs contrasting for these traits.

CONTACT

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