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

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Abstract
The aim of the present study was to evaluate the effects of birth weight (BW; low vs. high) and genetic capacity to deposit protein (BV; low vs. high) on N-utilization in growing pigs in a N-balance study over a period of 16-18 weeks of age in a change-over design with two levels of dietary protein supply. High BW pigs had a higher N-intake, urinary N-loss (both $P<0.001$) and N-retention ($P<0.01$) compared to low BW pigs of the same age. However, N-efficiency (%) was not affected by BW. Pigs with a high BV had a lower urinary N-excretion and improved efficiency for N-retention (% of N-ingested) (both $P<0.05$). In conclusion, BW and BV both affect absolute retention of body protein in the grower phase. However, nitrogen efficiency (%) is only influenced by BV but not by BW.

Keywords: pigs, birth weight, protein deposition capacity, protein efficiency

Introduction

Further improvement of feed and nutrient efficiency in pigs requires information on animal traits related with the requirements for nutrients. For example, birth weight and genomic information of animals are hardly used in nutrient formulation of diets, but might be important to consider in the development of concepts of precision feeding. Rehfeldt and Kuhn (2006) showed that a low foetal growth and birth weight leads to a lower number of muscle fibres formed prenatally and a lower body protein content in low birth weight piglets. Therefore, such piglets may show a lower performance and nutrient efficiency later in life. The aim of the present study was to evaluate the effects of BW and BV on N-utilization in growing pigs in a N-balance study.

Material and methods

Two groups of 20 male pigs ((Tempo ♂) x (York x Dutch Landrace ♀)) were selected with a low (1.04 kg) or high BW (1.80 kg), and within birthweight a low or high BV (-2 and +11 g/d, respectively, relative to an average crossbred pig with a protein deposition of 146 g/d). BV was derived from DNA sequencing of the individual pigs and genomic prediction of protein deposition capacity (Topigs Norsvin, The Netherlands). Pigs were subjected to N-balance measurements using quantitative urine and faeces collection in two sequential periods of 5 d. Pigs (14 weeks of age at the start of the adaptation period) were fed a protein sufficient (CP 163 g/kg; 100%) diet or a diet providing only 70% of the amount of protein relative to the protein sufficient diet in a change-over design. Diets contained casein, wheat gluten meal and potato protein as protein sources and were fed at 2.8 x M equally divided over two meals per day. Low and high BW pigs weighed 53 and 63 kg, respectively, at the start of the adaptation period before the first balance period. Pigs were housed in metabolic cages from 11 d prior to the start of the balance periods. Results were analysed statistically using ANOVA with sequence of dietary treatment, birth weight, breeding value for protein deposition and dietary protein supply and their interactions as factors.

Results and discussion

N-balance parameters for the experimental treatments are given in Table 1. High BW pigs had a higher N-intake, urinary N-loss (both P<0.001) and N-retention (P<0.01) compared to low BW pigs of the same age. However, efficiency of N-retention was not affected by BW. A high breeding value for protein deposition reduced urinary N-excretion and improved N-utilization (both P<0.05). Restricted dietary protein supply reduced dietary N-intake, urinary N-excretion, and N-retention, but increased efficiency of ingested N to retained N in the body.

Table 1. Effects of birth weight (BW), breeding value for protein deposition (BV) and dietary protein supply (adequate vs. restricted) on N-balance parameters and N-efficiency in growing pigs.

	BW		BV		Protein supply		P-values[1]		
	Low	High	Low	High	Adq	Res	BW	BV	Diet
N-intake, g/d	41.7	47.7	45.0	44.2	51.6	37.7	<0.001	0.37	<0.001
N-faeces, g/d	3.7	4.0	3.9	3.8	3.7	4.0	0.27	0.33	0.12
N-urine, g/d	15.2	18.1	17.5	15.8	20.7	12.7	<0.001	0.02	<0.001
N-retention, g/d	22.8	25.5	23.6	24.7	27.2	21.1	0.004	0.19	<0.001
N-retention, %	54.8	53.4	52.7	55.8	52.7	55.8	0.42	0.04	0.003

[1]Interactions were observed between BW x Protein supply for N-intake (P<0.001) and BV x Protein supply for N-excretion in urine (P<0.01) and N-retention (P<0.05).

Low BW piglets continue to remained behind in growth performance in the grower period, similar to results of Fix et al. (2006). Low BW piglets do not have a lower N-efficiency in this phase compared to high BW piglets, although the first may have a lower number of muscle fibres and a lower body protein content compared to high BW pigs. Efficiency of ingested N for N-retention was higher in pigs with a high than in pigs with a low BV for protein deposition. This suggests that protein and amino acid metabolism might be more efficient in pigs with a high BV for protein deposition. These pigs may have higher requirements for protein and amino acids compared to low BV pigs. Restriction of the supply of dietary protein reduced absolute protein deposition, but increased N-efficiency for body protein retention. In conclusion, both birth weight and genetic capacity for protein deposition seem important traits to consider in future precision feeding systems.

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