PE1.18 Foetal programming of postnatal growth, and meat and carcass quality 147.00

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***Abstract*—Studies in humans have revealed that small size at birth involves increased risk of obesity in adulthood. This phenomenon is termed 'foetal programming', and is also of great interest in relation to pig production and the foetal effects on postnatal performance and carcass quality. The overall aim of this study was to examine the long-term effects of protein nutrition during foetal development, as well as the effect of birth weight within litter, on postnatal growth, carcass and meat quality of the offspring at slaughter. 16 pure-breed Danish Landrace gilts were used in this study, where 8 gilts were fed a norm diet and the remaining 8 gilts were fed a isocaloric 50 % protein reduced diet throughout gestation and lactation. Offspring were slaughtered at 150 d of age. Maternal low protein diet did not affect postnatal growth or meat quality, and had a positive effect on lean meat percentage. Pigs with a low birth weight had a significantly slower growth rate postnatal than heavier littermates, but carcass composition did not seems to be affected. LW pigs had a lower pH 45 min *post mortem* and a slightly higher shear force.**

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***Index Terms*—Carcass quality, Maternal protein restriction. Meat quality, Postnatal growth**

I. INTRODUCTION

Epidemiological studies in humans have revealed that small size at birth involves increased risk of developing metabolic dysfunctions, like obesity and type 2 diabetes, in adulthood. This phenomenon is termed 'foetal programming'. This has led to increasing interest in the long-term consequences of nutrition during pregnancy on both metabolism and body composition. In relation to the production of slaughter pigs, there are several overlapping points of interest between the human and the porcine aspects of growth during foetal life and postnatal consequences. Firstly, intra-litter variation in birth weight and thus foetal growth are large in pigs, and several studies have shown that pigs small at birth has a decreased growth postnatal [1, 2]. Also body composition seems to be affected by size at birth as small pigs tend to have a fatter carcass at slaughter [2]. Secondly, a reduction in protein-rich feed in pig production would be of great importance in relation to the environment and therefore sustainability, but on the other hand may have detrimental effects on foetal and postnatal growth. Thus, the overall aim of this study was to examine the long-term effects of protein nutrition during foetal development, as well as the effect of birth weight within litter, on postnatal growth, carcass and meat quality of the offspring at slaughter.

II: MATERIALS AND METHODS

a. Animals and feed

16 pure-breed Danish Landrace gilts were used in this study. From the day of mating and until farrowing, 8 sows were fed according to norm with a diet containing 16 MJ/kg ME, 13.6 % crude protein, 4.6 % crude fat and 6.1 % crude fiber. The remaining 8 sows were fed a isocaloric diet reduced approx. 50 % in protein containing 16.5 MJ7kg ME, 9.2 % crude protein, 6.0 % crude fat and 9.7 % crude fiber. After farrowing, the sows were kept on either norm or low protein diet throughout a 4 week lactation period. The norm lactation diet contained 16.7 MJ/kg ME, 16.6 % crude protein, 5.5 % crude fat and 4.4 % crude fiber, and the low protein lactation diet contained 16.9 MJ/kg ME, 9.1 % crude protein, 8.2 % crude fat and 8.2 % crude fiber.
At weaning, the low birth weight male and female pig and the high birth weight male and female pig within each litter were separated into individual pens, and fed either according to norm or a 30 % protein reduced diet until slaughter at 150 days of age. Male pigs – not castrates – were used in this study. In this paper, only the maternal nutrition will be discussed – not the postnatal diets.

b. Slaughter procedure

All pigs were slaughtered when they reached 150 d of age. They were individually stunned by CO_2 before slaughter. Live slaughter weight, hot carcass weight and the weight of the *M. Semitendinosus* from the left side was measured.

c. Meat quality

Meat quality traits were measured in the *M. Longissimus dorsi*. The pH and temperature were measured both 45 min and 24 h *post mortem*. Drip loss was measured over 48 h on approximately 100 g of muscle using the plastic bag method [3]. Colour was measured using a Minolta Chroma Meter CR-300 (Osaka, Japan) calibrated against a white tile (lightness = 92.30, redness = 0.32, and yellowness = 0.33). The samples were allowed to bloom for 1 h at 4°C before measuring at 5 different places on each sample.

d. Ham quality

After slaughter, half carcasses were scanned by Computed Tomography (CT) for determination of lean meat percentage in the ham [4]. See Figure 1 and 2.

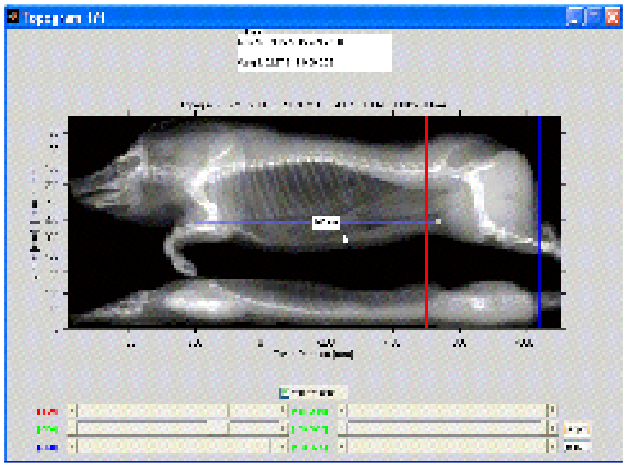

Figure 1. Definition of the ham region in which the meat percentage was calculated.

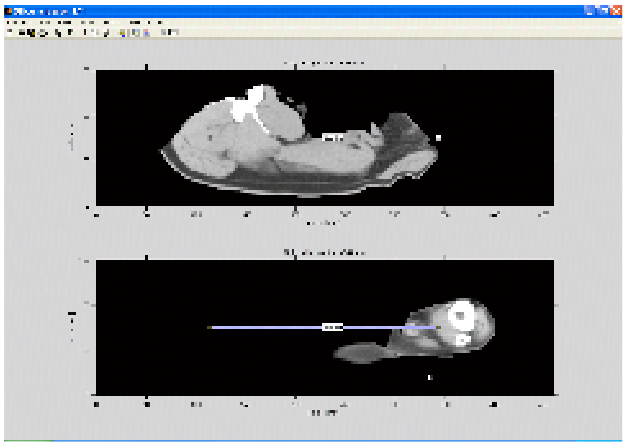

Figure 2. Upper window: left limit is the slice before the pubis bone appears moving caudally; Lower window: right limit is the slice where the bones separate and the marrow disappears.

III. RESULTS AND DISCUSSION

Maternal low protein diet has in early studies shown to have a negative effect on postnatal growth of the offspring. In this study, a 50 % reduction in protein intake during gestation and lactation did not affect birth or weaning weight (Table 1). Neither was average daily gain from birth until slaughter affected by maternal low protein. At the slaughter age of 150 d, live body weight, hot carcass weight and the weight of *M. Semitendinosus* were not different between treatment groups. Although there was no effect on slaughter weight, the amount of flare fat was significantly lower in offspring from protein restricted sows compared to norm fed sows. Also the meat percentage in the ham determined by CT-scanning were significantly higher in offspring from low protein fed sows than from norm fed sows. These results indicate that overall body growth of the offspring is not affected by maternal protein level, but indicate that carcass composition and therefore quality is affected in that low protein diet during gestation and lactation improves the lean meat content in the carcass. The meat quality traits measured in this study was not affected by maternal protein level (Table 1)

Birth weight - and thus foetal growth - seems to be important for the growth of the pig postnatal. In this study we found that LW pigs had a decreased average daily gain from birth until slaughter which significantly affected the live body weight and hot carcass weight at 150 d of age (Table 2). Also the amount of flare fat and the weight of *M. Semitendinosus* were lower in LW pigs even after correcting for slaughter weight. CT-scanning of the ham did not reveal any differences in meat percentage between LW and HW pig littermates.

Several meat quality traits were measured after slaughter (Table 1) but only pH_{45min} *post mortem* and the shear force were affected. Thus, LW pigs had a higher pH shortly after slaughter indicating that the pH fall may be slower. This could influence the drip loss and L* positively which was also found although not significantly. The shear force was found to be higher in LW pigs indicating a lower tenderness. This is in agreement with results from other studies [2], and is possibly connected with the lower growth rate of LW pigs at slaughter indicating slower protein degradation both before and after slaughter.

IV CONCLUSION

This study has shown that a 50 % reduction in maternal protein intake during gestation and lactation do not negatively affect growth or meat quality in the offspring. Surprisingly, low protein diet seems to have a positive effect on the lean meat content of the offspring. More studies within this area is needed to reveal to what extent low maternal protein diet affects later litter performance of the sows, but this could be a way to reduced the nitrogen loss from pig farming without affecting performance and quality.

This study has also shown that birth weight is directly associated with growth performance postnatal in that LW pigs growth slower from birth to slaughter than their heavier littermates. No effect on lean meat percentage in the ham was found indicating that carcass quality was not affected by birth weight. Meat quality was slightly affected in a positive direction in relation to pH but negatively in relation to shear force.

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Table 1. Growth and meat quality traits in offspring from sows fed either norm or low protein diet during gestation and lactation.

	Norm diet	Low protein diet	P
No. of pigs	33	32	
Growth traits:			
Birth wt, kg	1.35	1.35	NS
Weaning wt, kg	7.3	7.3	NS
Average daily gain, g	545	512	NS
Live body wt at slaughter, kg	83.2	78.1	NS
Hot carcass wt, kg	62.1	59.0	NS
Flare fat, g*	653	543	< 0.05
Wt of *M. Semitendinosus*, g*	278	275	NS
CT-measured meat percentage in ham	67.2	69.2	< 0.05
Meat quality traits:			
pH_{45min}*	6.16	6.20	NS
$Temperature_{45min}$*	34.2	34.1	NS
pH_{24h}*	5.54	5.61	NS
$Temperature_{24h}$*	3.7	3.4	NS
Drip loss, %*	7.7	10.2	NS
L*(lightness)*	54.5	55.4	NS
a*(redness)*	7.4	6.9	NS
b*(yellowness)*	4.8	5.2	NS
Shear force, N*	50.9	48.6	NS

*Corrected for slaughter weight

Table 2. Growth and meat quality traits in pigs at slaughter with either a low (LW) or high (HW) birth weight within litter.

	LW	HW	P
No. of pigs	32	33	
pH_{45min}*	6.24	6.11	< 0.05
$Temperature_{45min}$*	34.1	34.2	NS
pH_{24h}*	5.57	5.58	NS
$Temperature_{24h}$*	3.5	3.5	NS
Drip loss, %*	8.5	9.3	NS
L*(lightness)*	54.5	55.5	NS
a*(redness)*	7.1	7.2	NS
b*(yellowness)*	4.7	5.2	NS
Shear force, N*	52.2	47.3	0.052

*Corrected for slaughter weight