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EARNEST

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Prenatal dietary intervention

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Introduction

We used sows as a model species in this study. One of the current issues in swine husbandry is the high mortality rate of new born piglets. This high mortality rate is a consequence of increased litter size due to genetic selection. Uterine capacity of the sow is limited, meaning that when nowadays more piglets have to share the space in the uterus, resulting in lower birth weights, and less viable piglets at birth. In order to improve welfare of new born piglets and reduce mortality, foetal development may be stimulated. This can be done by nutrition of the gestating sow. Energy and amino acid intake of the sow in gestation may influence litter size and characteristics of neonatal piglets and long term programming of body composition and glucose and fat metabolism. Previous studies have indicated a differential effect of starch and fat in gestating diets on glucose tolerance of sows and nutrient supply of foetal piglets. Furthermore, recent studies indicated an effect of amino acids, esp. arginine on litter size or viability of piglets. In this study we compared the effect of three experimental diets for gestating sows (control, high fat and high protein) and two feeding schemes (low-high and high-low) in gestation in a 2x3 factorial design on body development and reproduction of sows, and viability and gain of piglets in the suckling period.

Aim

The aim of this study was to determine the influence of caloric and amino acid intake in specific periods in gestation on development and reproduction of sows and viability, growth and metabolism of piglets.

Experimental design

The experiment comprised 6 treatments in a 2x3 factorial design. We used a low-high (LH) and a high-low (HL) feeding scheme, supplying equal net energy during the total gestation. Sows of the LH treatments received 25 MJ NE/d in D 0-70 of gestation and 33 MJ/d in D 71-110. Sows of the HL treatments received 33 MJ NE/d in D 0-40 of gestation and 25 MJ/d in D 41-110. Sows received one of three diets, containing a high starch control diet or a high fat or protein (esp. arginine, glutamine and proline) diet. Fat and protein were exchanged for starch. The high fat diet contained a higher energy level; this was taken into account in the feed allowance, thus supplying all sows an equal amount of net energy daily. From Day 111 of gestation to weaning all sows received the same lactation diet, adequate in energy and other nutrients.

Treat.	Diet	Feed scheme
1.	Control, starch	low-high
2.	High fat	low-high
3.	High protein	low-high
4.	Control, starch	high-low
5.	High fat	high-low
6.	High protein	high-low

The experiment comprised 28-30 sows per treatment. Measurements included feed intake, body weight and back fat of sows, birth weight and weight gain of piglets, variation within litters, and mortality. Eight sows per treatment were used for additional measurements of blood glucose and glucose tolerance and milk composition. One low and one median piglet/litter was sacrificed, organs were weighed and organs and tissues were sampled for molecular biology.

Results

- In the whole gestation period, energy intake was similar for the LH and HL feeding scheme. Energy intake was slightly higher for the high fat diet compared to the two other diets. Voluntary feed intake in lactation was not affected by dietary treatment in gestation.
- The HL feeding scheme resulted in a higher growth rate of sows in early gestation and a lower body gain in late gestation. Overall sows at the HL scheme showed a slightly lower body gain (3 kg) and higher back fat deposition (0.3 mm) in gestation. This indicates that the timing of nutrient supply influence the utilization for (maternal) protein or lipid deposition. Priority for lipid deposition is higher in early gestation than in late gestation. Despite the low feeding level in late gestation birth weight of piglets was not affected. Apparently the sows compensated for the variation in feeding scheme by a lower or higher maternal tissue (protein and fat) deposition, thus indicating the high priority for foetal growth when nutrient availability is limiting. The lack of effect of the feeding level in late gestation on birth weight was in agreement with some recent publications and maybe related to the body composition of sows. It may be speculated that in thin sows with less body reserves a low feeding level may cause a lower birth weight of piglets.
- The HL feeding schema resulted in a lower litter size. This was somewhat unexpected because of recent evidence that a low feed intake in early gestation may reduce litter size. However, it may well be that beyond a feed allowance of approximately 3 kg no further benefit of a higher feed allowance is to be expected. The feeding scheme did not influence viability (mortality) or growth rate of suckling piglets. Hence, there was no evidence of a beneficial effect of a higher nutrient supply in early gestation during placental growth and development or in late gestation during rapid foetal growth. Long term effects on gain and body composition are not available yet.
- Dietary protein content did not influence body gain in sows. However, sows receiving the high fat diet realised a lower body gain and back fat deposition than sows receiving the high starch (control) diet or the high protein diet. It seems likely that because of a too high fat supply or a too low glucose (starch) supply sows oxidised fatty acids rather than using these for lipid deposition, thus reducing the energetic efficiency of utilisation. Moreover, a metabolic or endocrine response to the high starch levels in the control diet may have played an important role.
- Diet composition did not influence birth weight, mortality, body gain or weaning weight of piglets. This illustrates the priority for foetal growth above maternal gain since the high fat diet resulted in a lower maternal gain, without effect of neonatal piglets. Recent studies discussed the relevance of arginine, proline and glutamine, being precursors of

polyamines and NO for placental development. Therefore, and because of recent results indicating beneficial effects of arginine in specific periods of gestation on litter size or number of live born piglets we hypothesised that the increase in these amino acids may improve litter size and/or viability of piglets. Our results do not support these effects, only for the LH feeding scheme we found a numerical increase in litter size (not significant) for the high protein diet.

- The high fat diet resulted in a lower percentage of still born piglets, but only on the LH feeding scheme. Previous studies at our institute and in literature also indicate effects of dietary lipid content on still birth of piglets, although results were not consistent. The reasons for these effects are not quite clear and deserve further attention. An interaction with glucose tolerance of sows can not be excluded; these results will come available later.

Conclusions

- Sows adjust their maternal tissue deposition in gestation to the available nutrient supply, with high priority for foetal growth.
- Maternal fat deposition has a higher priority in early gestation than in late gestation.
- Feed allowance in late gestation has little effect on birth weight of piglets.
- Feeding scheme (distribution of feed in gestation) has little effect on viability and growth of suckling piglets.
- A high fat and low starch diet in gestation has a negative effect on maternal growth without obviously compromising foetal growth and birth weight.
- Increasing the arginine, proline and glutamine supply in gestation does not have any apparent direct effect on viability and growth rate of piglets.
- Dietary fat content may affect still birth of piglets.