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Feeding sows with high fibre diet around farrowing and early lactation: Impact on intestinal activity, energy balance related parameters and litter performance

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ABSTRACT

The effects of fibre in diets for periparturient sows are poorly documented. Three weeks before farrowing, 41 sows (LACT) were fed a diet containing 3.8% crude fibre. Other 40 sows (FIBRE) received a diet containing 7% crude fibre. We estimated the intestinal activity of the sows with a daily qualitative evaluation of their faeces. The FIBRE group had a qualitative faeces score value of 2.1 ± 1.3 and the LACT group had a value of 1.2 ± 1.1 ($P < 0.001$). Individual daily water consumption was higher in the FIBRE group than in the LACT group ($P < 0.001$). Piglet weight gain at day 5 was higher in the FIBRE group ($P < 0.05$). The energy balance related parameters did not differ between the treatments.

Concluding, diets containing more fibre can be successfully used around farrowing reducing prolonged constipation of sows with no negative effect on their energy balance related parameters.

1. Introduction

During late pregnancy, one common practice of feeding sows aims to reduce the amount of feed offered and to increase the energy of the ration. Such concentrated diets usually contain a more limited amount of fibre than do standard pregnancy diets. This practice aims mainly to ensure that sows receive enough energy during late pregnancy to satisfy upcoming milk production (Einarsson and Rojkittikhun, 1993). However, previous studies have reported that reducing the volume and fibre content of sow feeds can have negative effects, such as increased stereotypic behaviour (Ramonet et al., 1999), the development of gastric ulcers and constipation (Lee and Close, 1987). As sows approach farrowing, mild constipation is a common state because the intestine is less active due to coming parturition (Kamphues et al., 2000). In addition, water absorption in the intestine increases due to the fluid request resulting from the beginning of milk production (Mroz et al., 1995). Offering feed low in volume and fibre can worsen constipation, thus increasing the risk of bacterial toxins to be absorbed and targeting the udder (Smith, 1985). In addition, another study, in which constipated sows showed higher rates of mastitis than did unconstipated ones, found evidence of a direct effect of constipation on udder health (Hermansson et al., 1978). Constipation may also be uncomfortable for the sows, thus decreasing their welfare.

Fibre contains substances like lignin, hemicellulose, cellulose, fructans and pectins. These substances are resistant to the digestive enzymes of animals. However, in pigs some of the fibre digestion can take place in the caecum and colon due to the action of cellulolytic bacteria. This digestion produces volatile fatty acids which can provide up to 28% of the energy balance of growing pigs and even more in sows (Noblet and Le Goff, 2001). The number of cellulolytic bacteria increases with the age of the animal, and researchers have calculated that the large intestine of mature sows contains as much as six times more cellulolytic bacteria than do the intestine of growing pigs (Varel and Pond, 1985). Although its use in nonruminants' diets presents some limits, fibre can evidently produce a broad number of benefits that require more research, especially in periparturient sows.

Our aim was to determine whether doubling the amount of fibre in a standard commercial lactating diet fed to sows in late pregnancy and early lactation would improve intestinal activity (as an indication of motility of the gut) without negatively affecting the energy balance related parameters of the sow.

2. Materials and methods

2.1. Animals, feeding treatments and management

To perform this study, we used 81 sows (Finnish Yorkshire × Finnish Landrace) in a sow-pool system (Dalin et al., 1997). The sows were inseminated in the nucleus herd, where they were loose-housed in groups of 38–40 animals until approximately day 95 of pregnancy. The sows were then moved to a satellite herd and initially placed in two separated loose-housed groups of 19–22 sows and group fed until day 106, after which they were moved

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into individual farrowing crates. At weaning, after 28 days of lactation, they were returned to the nucleus herd.

We conducted the study in four replicates (n = 19; n = 22; n = 20 and n = 20) from spring to autumn. The treatment groups were equally represented in all replicates. Upon their arrival in the satellite herd (day 95 of pregnancy), we randomly assigned 41 sows to the LACT group, fed daily 3.2 kg (41.2 MJ/day) of a commercial lactating diet containing 3.8% crude fibre (Imetys-Pekoni®, Suomen Rehu Ltd., Finland) till day 5 of lactation, thereafter increased by 0.5 kg/day till day 13 of lactation and then maintained till weaning. Another 40 sows were included in the FIBRE group, fed daily 3.8 kg (41.3 MJ/day) of a commercial pregnancy diet containing 7% crude fibre (Tiineys-Pekoni®, Suomen Rehu Ltd., Finland). The FIBRE group on day 3 of lactation was switched to the LACT group diet protocol till weaning. The composition of the two diets appears in Table 1. The animals were fed twice daily, at 09:00 and 17:00. No considerable feed refusal was observed during the whole study. Since the experiment was conducted in a commercial piggery, two days before the expected farrowing, the amount of feed was halved until day 1 of lactation in both groups, following a very common feeding practice in Scandinavia. The parity of the sows ranged from 2 to 8 with an average ± SD of 4.0 ± 1.5 for the FIBRE group and 5.0 ± 1.8 for the LACT group. Artificial lights were on from 08:00 to 18:00 and the temperature ranged between 17 and 20 °C. The floor of the farrowing crates was cleaned once daily in the morning before feeding time.

The experimental protocol was approved by the "Ethical Committee for Institutional Animal Use and Care" of the Helsinki University with the decision HY 52-06.

2.2. Blood samples, the intestinal function score of the sows and piglets' growth

We took blood samples from all of the sows undergoing both treatments in the first two replicates (n = 41). We took one blood sample on approximately day 85 of pregnancy in the nucleus herd. The sampling continued daily, from five days before to five days after farrowing, in the satellite herd. These samples were taken twice daily: the first at around 08:00, one hour before feeding, and the second at around 10:00, one hour after feeding. This sampling plan allowed us to control the pre- and post-feeding values of non-esterified fatty acids (NEFAs), urea, creatinine, glucose and insulin. We took blood samples from vena saphena medialis, and centrifuged them at 3500 rpm for 10 min. The serum obtained was immediately frozen at −20 °C until analysis.

We also measured the back-fat layer in the same sows (n = 41) in the first two replicates using a digital back-fat indicator (Renco lean-meater®, Renco corporation, Minneapolis, MN, USA). We took five measurements: one on around days 85 and 107 of pregnancy, at farrowing, during early lactation and at weaning. The back-fat digital indicator probe was placed on the back of the sow at the level of the last rib, 6–7 cm from the side of the backbone.

We monitored the intestinal activity of all of the sows in the four replicates (n = 81), from five days before to five days after farrowing, making a daily qualitative evaluation of the faeces. Every morning before the daily cleaning, we ranked the faeces of each sow by visual qualitative evaluation. We assigned a score value ranging from 0 to 5, with 0 (absence of faeces), 1 (dry and pellet-shaped), 2 (between dry and normal), 3 (normal and soft, but firm and well formed), 4 (between normal and wet, still formed but not firm) and 5 (very wet faeces, unformed and liquid).

Depending on the number of consecutive days with no faecal production, we classified the grade of constipation as mild (no faeces for two consecutive days), severe (no faeces for three or four consecutive days) and extremely severe (no faeces for more than five consecutive days).

We followed the growth of all 41 litters in the two first replicates by individually weighing the piglets on days 1 and 5 of life with an electronic scale (Ahti® OCS-20B, Kivikangas Oy, Finland). Post-mortem investigation was carried out by a pathologist for all piglets that died during the first five days of life, for the first two replicates (41 litters).

2.3. Water consumption

We installed in the farrowing room eight water counters, which provided us information about the daily water intake of eight different groups of sows (2–3 sows/counter), four groups for each treatment. Every morning we measured the water consumption from each counter and estimated the mean daily individual water intake of the sows, dividing the total daily water consumption measured in one counter by the number of sows present at that counter. During the whole study a total of 60 sows were observed and 24 mean observations obtained, 12 from each treatment.

2.4. Assays

Concentrations of NEFA were measured using an enzymatic, colorimetric method with a NEFA-C kit® (Waco Chemicals GmbH, Neuss, Germany) as described by Campbell et al. (1990). We determined the urea concentration with an enzymatic, kinetic UV method (Urea UV 250®, BioMerieux, Marcy-l'Etoile, France) as described by Gutmann and Bergmeyer (1974). A kinetic, colorimetric method (Creatinine-Jaffe®, Thermo Fisher Scientific Oy, Vantaa, Finland) was used to measure creatinine as described by Fabiny and Ertigshausen (1971). We measured the concentration of glucose with an enzymatic, colorimetric method (Glucose GOD-POD®, Thermo Fisher Scientific Oy, Vantaa, Finland) as described by Trinder (1969). Insulin concentration was assessed using an ELISA assay (Porcine Insulin®, Mercodia, Uppsala, Sweden), according to manufacturer instructions. The minimum detectable amount of standard in the assay was 0.05 μg/l. The concentration of insulin was obtained by computerised data reduction of the absorbance for the calibrators, except for calibrator 0, vs the concentration using cubic spline regression. The intra-assay coefficient of variation (CV) for Porcine Insulin ELISA was 6.2% for low values (0.1 μg/l) and 3.6%

Table 1
Ingredients and composition of the two diets

	LACT diet[a]	FIBRE diet[b]
Ingredients (%)		
Wheat	30.00	–
Barley	18.74	32.17
Oats (uncoated)	15.00	–
Soy (crushed)	12.20	4.10
Oats	5.00	27.00
Vegetable fat	4.50	0.50
Sugar beet (dry and sliced)	4.00	8.00
Wheat bran	2.00	15.00
Wheat feed flour	2.00	10.00
Premix	1.84	1.25
Monocalcium phosphate	1.12	0.47
Calcium carbonate	0.78	0.75
Amino acids	0.54	0.23
Salt	0.45	0.50
Composition calculated (%)		
Crude protein	16.8	13.5
Crude fat	6.8	4.1
Crude fibre	3.8	7.0
Fibre details (g/kg)		
NDF	140	250
NSP	140	280

[a] MJ/kg = 12.9, 3.2 kg/sow/day, 41.2 MJ/sow/day and MJ = NE.
[b] MJ/kg = 10.9, 3.8 kg/sow/day, 41.3 MJ/sow/day and MJ = NE.