Animal Feed Science and Technology 232 (2017) 169–181

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Increased dietary protein levels during lactation improved sow and litter performance

Anja V. Strathe[a,*], Thomas S. Bruun[b], Niels Geertsen[a], Jens-Erik Zerrahn[c], Christian F. Hansen[a]

[a] Department of Veterinary and Animal Sciences, Faculty of Health and Medical Sciences, University of Copenhagen, Grønnegårdsvej 2, 1870 Frederiksberg, Denmark
[b] SEGES Danish Pig Research Centre, Axeltorv 3, 1609 Copenhagen, Denmark
[c] Evonik Nutrition & Care GmbH Tyskland Filial Denmark, Damhaven 3, 7100 Vejle, Denmark

ARTICLE INFO

Keywords:
Dietary protein
Lactation
Litter weight gain
Milk composition
Reproduction
Sow performance

ABSTRACT

The study was conducted to investigate the effect of increasing balanced dietary protein for hyper-prolific lactating sows. In total 544 sows (parity 1–4) was allotted to one of six diets from day 2 post-partum until weaning. The diets were analyzed to have a standardized ileal digestible (SID) crude protein (CP) level of 104.3, 113.3, 120.9, 128.5, 139.2 or 150.0 g/kg. At d 2 post-partum litters were standardized to 14 piglets and body weight (BW), back fat (BF) thickness of sows and litter weight were recorded. Body weight, BF thickness and litter weight was also recorded at weaning. On a subsample of 70 sows (parity 2 and 3) milk samples were obtained at day 3, 10 and 17 post-partum and analyzed for fat, CP and lactose. In the analysis of the dose-response data the dietary SID CP concentration were used as explanatory variable. The above-mentioned response variables were fitted with linear broken-line, quadratic broken-line and linear regression models. Sow BW and BF loss reached a break point at 143 g SID CP/kg and 127 g SID CP/kg, where sows lost 0.58 kg/d and 3 mm, respectively ($P < 0.001$). Multiparous sows had a higher average daily gain of the litter than first parity sows (3.07 vs. 2.53 kg/d) at the break point at 135 g SID CP/kg ($P < 0.001$), but litter size (13.0 ± 1.2 piglets) at weaning was unaffected by dietary treatment ($P = 0.30$). Milk CP increased to 5.0 g/100 mL until a break-point at 136 g SID CP/kg, milk lactose decreased until a breakpoint at 120 g SID CP/kg to 5.3 g/100 mL ($P < 0.001$) and milk fat increased linearly ($P < 0.05$). The daily output of milk protein was increased at day 17 until a breakpoint at 130 g SID CP/kg (663–670 g/d; $P < 0.001$). The content of milk fat increased linearly with increasing dietary SID CP ($P < 0.05$). There was a tendency towards an increased number of total born piglets in next litter with increased dietary SID CP ($P = 0.06$), whereas the weaning-to-estrus interval was unaffected by treatment ($P = 0.83$). In conclusion, increasing dietary SID CP up till 135 g/kg or 850 g SID CP/d increased ADG of the litter, and this increase was caused by increased milk yield and increased daily protein output in milk.

Abbreviations: AA, amino acid(s); ADG, average daily gain; AIC, akaikes information criterion; BF, back fat thickness; BW, body weight; CP, crude protein; d, day; LSMeans, least squares means; NE, net energy; SID, standardized ileal digestible; WEI, weaning-to-estrus interval

* Corresponding author.
E-mail address: avst@sund.ku.dk (A.V. Strathe).

http://dx.doi.org/10.1016/j.anifeedsci.2017.08.015
Received 31 March 2017; Received in revised form 13 August 2017; Accepted 16 August 2017

1. Introduction

The modern sow has undergone major changes during the last decades and has become larger and leaner and gives birth to more piglets, but only few studies have recently investigated the effect of increasing dietary protein with a balanced AA composition of lactating sows (Laspiur et al., 2009; Manjarin et al., 2012; Huang et al., 2013). The high-producing sow nurses and weans more than 12 piglets (Strathe et al., 2016, 2017), placing an increased demand on the nutrient availability for milk production. Increasing milk yield and nutrient contents is essential to meet the energy and nutrient demand of the large litters. Several studies find a higher litter ADG when increasing dietary protein (King et al., 1993; Yang et al., 2000a; Manjarin et al., 2012), but only few have found an increased milk yield (King et al., 1993; Sauber et al., 1998). However, the increased ADG could be a result of increased nutrient concentrations of the milk and several studies have shown increased milk protein as response to dietary protein (Guan et al., 2004; Laspiur et al., 2009). During lactation many sows turn catabolic to meet the milk demand of the litter (Dourmad et al., 1998; Strathe et al., 2015, 2017). High mobilization of protein can have a negative effect on milk production and reproduction in the following cycle (Zak et al., 1997; Clowes et al., 2003b). In addition a high protein loss during lactation can be difficult for the sow to regain in the following gestation. (Everts and Dekker, 1995; Dourmad et al., 1996). Consequently, the objective was to test the effect of increasing dietary SID CP concentrations with similar AA composition on sow and litter performance. It was hypothesized that increasing the level of balanced dietary CP would have a positive effect on milk production and litter growth and prevent excessive body mobilization.

2. Materials and methods

This study was conducted with the approval of the Danish Animal Experimentation Inspectorate (Authorization No. 2013-15-2934-00961).

2.1. Experimental design, animals, and housing

The study was designed as a dose-response experiment to determine the minimum SID CP level (104–150 g SID CP/kg) to maximize sow and litter performance. The study was conducted in a commercial Danish herd using a total of 544 parity 1–4 sows (Landrace × Yorkshire, DanAvl, Copenhagen, Denmark) mated with Duroc semen (Ornestation Mors, Redsted, Denmark). The sows were randomly allocated based on parity to 1 of 6 dietary treatments (n = 90) with 6 dietary levels of SID CP (Table 1) in a complete block design. The distribution of parities was similar in all six treatment groups. The animals were studied from 4 days pre-partum (day 4.2 ± 1.6) to approximately 4 weeks post-partum when the piglets were weaned at day 24 (day 24.4 ± 1.2). The herd had 5 farrowing sections with individual farrowing pens (1.7 × 2.6 m and 1.6 × 2.5 m) that were used in the study. Treatments were randomly rotated within each section to ensure that sows receiving the same dietary treatments were not placed in the same pens in every block of sows. Each week a batch of 18 sows was included in the study, moved to the farrowing unit 4 days pre-partum and placed in individual farrowing pens. The study was performed in 31 consecutive weeks. The temperature in the farrowing unit was set to 20 °C and the farrowing unit was ventilated using negative pressure by wall inlets. In the farrowing rooms artificial light was on from 0700 to 1600 h. Each pen was equipped with a covered creep area with a heating lamp for the piglets. The heating lamp was regulated by infrared sensors (VengSystem A/S, Roslev, Denmark) and the temperature was gradually decreased from 34 °C at farrowing to 22 °C 15 d post-partum. Twenty four to 48 h (day 1.3 ± 0.7) post-partum (day 0) the litters of the experimental sows were standardized to 14 piglets (average BW: 1.76 ± 0.24 kg). All piglets had iron injections (0.5 mL; Solofer Vet., Pharmacosmos A/S, Holbæk, Denmark), were tail docked, and males were surgically castrated on day 3 or 4 post-partum with postoperative analgesia (0.1 mL; Melovem, Dopharma B.V., aamsdonksveer, The Netherlands). Besides the recordings made in the experiment all animals were managed according to the general routines of the piggery. Health of the animals was monitored by the stock personnel and normal practices for management, treatments and vaccinations of the herd were followed. It was recorded if the litter were treated for diarrhea during the experimental period. When dead or very weak piglets were removed from the litter, date and weight of the excluded piglet were logged. At weaning litter weight and number of piglet below 5 kg was noted.

2.2. Diets and feeding system

From day 4 pre-partum to day 2 post-partum all sows were fed the same commercial formulated lactation diet based on wheat, soybean meal and sugar beet pulp complying with Danish recommendations (Tybirk et al., 2013). From day 2 post-partum and until weaning sows were allotted to 6 dietary treatments varying in balanced SID CP concentration (Table 1), but formulated to be isoenergetic based on NE. The diets were formulated to fulfill the Danish dietary recommendations for essential AA composition of CP for lactating sows (Tybirk et al., 2013) and based on barley, wheat and soy bean meal (Table 1). It was intended to formulate diets based on normally used ingredients that would be practical applicable for the pig producer and therefore no so called “synthetic” diets were used. In the formulation of the six diets commercially available synthetic AA (Lys, Met, Tre, Val) were used in order to ensure the lowest possible CP concentration and that the dietary AA composition would be as close as possible to the recommendation (Tybirk et al., 2013).

From farrowing to day 10 of lactation sows were fed twice daily and from day 10 onwards sows were fed three times per day. All sows were fed 2.3 kg from farrowing and feed allowance was gradually increased to a maximum of 7.4 kg for primiparous sows and 8.4 kg/d for multiparous sows at day 17. Sows were fed using a SpotMix feeding system (Schauer Agrotronic, Prambachkirchen,