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Dietary ractopamine supplementation during the first lactation affects milk composition, piglet growth and sow reproductive performance

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ABSTRACT

Excessive mobilization of body reserves during lactation delays the return to reproductive function in weaned primiparous sows. This study tested the hypothesis that supplementing the lactation diets of first-parity sows with ractopamine hydrochloride would reduce maternal weight loss and improve subsequent reproductive performance. Gestating gilts were allocated to one of two treatment groups (n = 30 sows/treatment), with one group fed a standard lactation diet (2.5 g/Mcal LYS: DE) throughout lactation (CTRL), whereas the treatment group received the standard lactation diet supplemented with 10 mg/kg ractopamine hydrochloride (RAC) from d 1 to 13 of lactation and 20 mg/kg RAC from d 14 of lactation until artificial insemination (AI). Weaning occurred on d 21 of lactation, with AI occurring at the first post-weaning estrus. Compared to CTRL, RAC supplementation decreased ($P < 0.05$) liveweight loss between d 13 and 20 of lactation (4.3 ± 0.90 versus 1.3 ± 0.96 kg), and tended to increase ($P = 0.06$) the number of second litter piglets born alive (9.5 ± 0.52 versus 8.1 ± 0.74). Treatment (RAC versus CTRL) reduced milk protein levels on d 13 and 20 of lactation ($P < 0.05$), and piglet weight gain between d 13 and 20 of lactation (260 ± 0.01 versus 310 ± 0.01 g/day, $P < 0.01$). In conclusion, it is evident that dietary RAC altered milk composition and stimulated conservation of maternal body reserves during the third week of lactation, resulting in a beneficial effect on subsequent reproductive performance.

1. Introduction

High incidences of premature culling of sows reduce the productivity of the breeding herd and overall herd feed-conversion efficiency. Reproductive failure, particularly after the first lactation, is the primary reason for culling primiparous sows (Hughes and Varley, 2003). The high milk yield of modern sow genotypes, combined with the innate reduction in appetite of primiparous sows, results in insufficient feed consumption during the first lactation to meet requirements for maintenance, milk production and body growth (Clowes et al., 1998). The resultant nutritional deficit stimulates the catabolism of body reserves (Clowes et al., 2005), with high levels of tissue mobilization, from both fat reserves and skeletal protein, a primary cause of the delay, or failure, of primiparous sows to return to reproductive function post-weaning (Einarsson and Rojkittikhun, 1993; Clowes et al., 2003). High levels of protein mobilization during the first lactation suppress activity

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Table 1
Composition of the standard lactation sow diet.

Ingredient		Nutrient composition, calculated	
Item	%	Nutrient	Quantity
Barley	57.0	Dry matter, %	89.9
Wheat	14.25	MCal/kg DE	3.34
Peas	10.0	Crude Protein, %	18.7
Soyabean meal	6.0	Fat, %	6.21
Meat meal	5.0	Fibre, %	4.2
Fish meal	2.5	Calcium, %	1.0
Tallow	3.75	Lysine, %	1.0
Choline chloride	0.045	Available lysine, %	0.84
Lysine – HCL	0.14	Methionine, %	0.31
D, L-Methionine	0.025	Threonine, %	0.62
L-Threonine	0.01	Tryptophan, %	0.19
Mineral mix	0.25	Salt, %	0.54
Salt	0.3	Sodium, %	0.18
Limestone	0.75	Choline, ppm	1318.3

of the hypothalamic-pituitary-ovarian axis (Quesnel et al., 2005), extends the weaning to estrus interval (Jones and Stahly, 1999) and reduces post-weaning ovulation rate (Mejia-Guadarrama et al., 2002). It is, therefore, reasonable to suggest that if protein mobilization during the first lactation can be reduced, or prevented, then subsequent reproductive performance will be improved and level of culling among primiparous sows will be reduced. The addition of ractopamine hydrochloride, a widely used β-adrenergic agonist, to the diet of finishing swine increases net protein accretion, most likely due to a combination of increased protein synthesis and decreased protein degradation (Bell et al., 1998; Ross et al., 2011). The current study tested the hypothesis that dietary inclusion of ractopamine during the first lactation would reduce mobilization of maternal body reserves and lactating sow weight loss, resulting in improvements in subsequent reproductive performance.

2. Materials and methods

2.1. Animals

This experiment was conducted at the University of Adelaide's Piggery, Roseworthy, South Australia, with approval from the animal ethics committee of The University of Adelaide. The experiment was conducted in 4 replicates, with the first 2 replicates conducted in spring and 2 more conducted in autumn/winter.

2.2. Experimental treatments, housing and feeding

Gestating Large White gilts (n = 60) were weighed and P2 back fat was ultrasonically measured on day 110 of gestation. From day 110 of gestation until weaning, sows were housed in temperature controlled farrowing accommodation, with a temperature range of 17 to 24◦C. Gilts were blocked by body weight (BW) and P2 backfat and allocated to 1 of 2 lactation treatment groups (n = 30 sows/treatment): first-parity sows that were fed a standard lactation diet (CTRL; 3.34 Mcal/kg DE, 18.7%CP, 6.2% crude fat, 4.2% crude fibre, and 2.5 g/Mcal LYS:DE; Table 1) throughout lactation and during the period from weaning to artificial insemination (AI). The other first-parity sows received the same standard lactation diet supplemented with 10 mg/kg ractopamine hydrochloride (RAC; Elanco Animal Health, Macquarie Park, Australia) from days 1–13 of lactation and 20 mg/kg RAC day 14 of lactation until AI. Treatments began 24 h postpartum (designated as d0). During lactation, the amount of feed offered each day was stepped-up gradually, reaching a maximum offered of 6 kg/day the 4th d of lactation (3 meals/d), and daily feed disappearance was recorded for each sow. Pigs were weaned at 21 d of age, and all sows received 3 kg/day of their treatment diets between weaning and AI. Additionally, litter size was standardised to 9 piglets/sow within 24 h of farrowing, with piglets receiving only maternal milk as their feed source.

After weaning, sows were group-housed (3 sows/group), and boar exposure commenced on the 4th day after weaning (15 min of full), physical boar contact in a detection mating area at approximately 0900. At the first estrus after weaning, sows were AI twice, once in the afternoon following detection of first estrus and again approximately 18 h later at 1000 the following day. All AI took place in the detection mating area, with fence-line contact with a boar during the procedure. Inseminations were performed using disposable spirette catheters, with each AI consisting of an 80-ml dose (3×10^9 spermatozoa) of fresh (≤4 d old) extended semen of Large White and Landrace boars purchased from SABOR Pty., Ltd. (Clare, South Australia).

2.3. Animal measurements

2.3.1. Liveweight, body composition and reproductive parameters

On d 1, 14 and 20 of lactation, sows were weighed before feeding and P2 backfat was measured over the last rib (65 mm ventral to the vertebrae) with an Ausonics Impact Ultrasound machine equipped with a 3.5 mHz linear array probe (Ausonics International Pty., Ltd., Camperdown, New South Wales, Australia). Piglets within each litter were also weighed on d 1, 13 and 20 of their dam's lactation. In addition, post-weaning reproductive performance measures included the number of days from weaning to first estrus detection (weaning-to-estrus interval), the proportion of sows expressing estrus within 10 d of weaning, and subsequent (2nd) litter size.

2.3.2. Collection of milk samples

On d 3, 13 and 20 of lactation, milk samples were collected approximately 30 min after litter removal, and immediately after a 2-mL i.m. injection of oxytocin (Troy Laboratories, Glendenning, NSW, Australia) from at least 6 teats (5 mL/teat). Milk fat and protein of each sow's composite milk sample were measured by infrared spectroscopy (Bentley 2500 Combi; Bentley Instruments, Chaska, MN), calibrated before each assay with a standardized milk solution. Energy content (MJ/kg) was determined by multiplying concentrations of protein, fat and lactose by 0.0389, 0.0238, and 0.0164 MJ/g, respectively (Ramanau et al., 2004).