Importance of pre-mating nutritional and metabolic conditions for litter uniformity

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For piglet survival, as well as for piglet performance before and after weaning, high piglet birth weights and litter uniformity are crucial (Quiniou *et al*. 2002). Within-litter variation in birth weight seems to be the consequence of within-litter variation in early embryo development (Van der Lende *et al*. 1990), which in turn reflects variation in follicle and oocyte development (Pope *et al*. 1990). Insulin-stimulating sow diets before mating can improve litter uniformity (Van den Brand *et al*. 2006, 2009), probably through beneficial effects of insulin on IGF-1 and follicle development. Plasma insulin and IGF-1 levels and follicle development are also influenced by the metabolic state of the sow. Plasma insulin and IGF-1 levels and follicle development are suppressed in sows with severe body condition loss during lactation, and restoration of plasma insulin and IGF-1 levels and follicle development occurs in sows with a recovery period after weaning (Quesnel 2009). We studied in multiparous sows effects of (i) insulin-stimulating diets during the weaning-to-estrus interval (WEI) on follicle development and development and uniformity of pre-implantation embryos at day 10 of pregnancy (Wientjes *et al*. 2012a,b) and fetuses and placentas at day 42 of pregnancy; and (ii) pre-mating conditions related with sow metabolic state during lactation (body condition loss) and after weaning (length of weaning-to-pregnancy interval; WPI) on litter uniformity at birth.

Multiparous sows (n = 32) were fed an insulin-stimulating diet (dextrose plus lactose, both 150 g/day) at 4h-intervals or an isocaloric control diet at 12h-intervals during WEI. Total insulin secretion, absolute insulin levels and plasma IGF-1 levels were not affected by the dietary treatments, although contrasts were created in the insulin secretion patterns during WEI (6 short insulin peaks/day vs. 2 sustained insulin peaks/day). The dextrose plus lactose diet fed at 4h-intervals during WEI resulted in a lower pre-ovulatory LH surge (3.0 vs. 3.7 ng/ml, $P = 0.03$), smaller follicles at day 4 after weaning (6.1 vs. 6.5 mm, $P = 0.08$) and subsequently smaller corpora lutea (mean diameter: 9.6 vs. 10.0 mm, $P = 0.06$) and less developed embryos at day 10 of pregnancy (mean diameter: 6.4 vs. 7.1 mm, $P = 0.07$) compared with the control diet fed at 12h-intervals. Independent of treatment, positive relations were found between mean insulin levels during WEI and subsequent progesterone levels ($\beta = 0.27$ (ng/ml)/(μU/ml), $P = 0.05$) and embryo development (mean diameter: $\beta = 0.06$ mm/(μU/ml), $P = 0.09$), but not embryo uniformity at day 10 of pregnancy. Whether and how this results in a more uniform development of fetuses and piglets at later stages of pregnancy was the focus of a follow-up experiment, in which multiparous sows (n = 54) were isocalorically fed (2x/day) an insulin-stimulating diet supplemented with dextrose plus corn starch (both 375 g/day or both 172 g/day) or a control diet during WEI. Postprandial insulin responses, both insulin peaks (< 1h after feeding) and long-term insulin level (~ 4h after feeding), were successfully stimulated during WEI by the insulin-stimulating diets in a dose-dependent manner, but plasma IGF-1 levels during the first three days after weaning were not affected. Follicle development and subsequent development and uniformity of fetuses and placentas at day 42 of pregnancy were not affected by these insulin-stimulating diets, nor related with plasma insulin and IGF-1 levels during WEI. Because uniformity of embryos or fetuses and placentas was not influenced by the insulin-stimulating diets during WEI, nor related with plasma insulin and IGF-1 levels during WEI, these experiments do not confirm that nutritionally increased plasma insulin and IGF-1 levels during only WEI can improve subsequent litter uniformity in multiparous sows.

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To study effects of pre-mating conditions related with sow metabolic state during lactation (body weight loss and backfat loss during lactation) and after weaning (length of WPI) on litter uniformity (SD and CV of birth weight), individual piglet birth weights (live born and stillborn) were determined at one farm. Litter uniformity at birth was significantly higher in sows with a WPI of >21 days and numerically higher in sows with a WPI between 8 and 21 days compared with sows with a WPI of ≤7 days (Table 1). In sows with a regular WPI (≤7 days; n = 808), litter uniformity at birth was negatively and linearly related with body condition loss during previous lactation (of 26±3 days). For example, a higher body weight loss during previous lactation [≤3.5% (20% lowest class) vs. >13% (20% highest class)] resulted in +28 g in birth weight SD (P = 0.02). A higher backfat loss during previous lactation [≤2 mm (20% lowest class) vs. >5 mm (20% highest class)] resulted in +25 g in birth weight SD (P = 0.04) and +1.8% in birth weight CV (P = 0.05).

Table 1. Effects of weaning-to-pregnancy interval (WPI) on litter characteristics of total born piglets at birth (LSM ± SEM).

	WPI ≤7 days	*WPI 8 to 21days*	*WPI >21 days + repeat breeders*	*SEM*	*P-value*
Number of litters, n	1,584	72	182		
Total number born, n	13.7[a]	14.9[b]	14.4[b]	0.3	<0.01
Mean birth weight*, g	1,428	1,438	1,431	17	0.83
SD of birth weight*, g	310[b]	291[ab]	287[a]	7	<0.01
CV of birth weight*, %	22.2[b]	20.8[ab]	20.5[a]	0.5	<0.01

* Corrected for the effect of total number born; [ab] Within rows, values lacking a common superscript differ (P≤0.05).

To conclude, pre-mating conditions related with sow metabolic state can affect subsequent litter uniformity. Litter uniformity at birth was compromised by severe sow body condition loss during previous lactation and improved in sows with a prolonged WPI. These results confirm that litter uniformity at birth is already (partly) determined during the pre-mating period, likely related with (insufficient) restoration of follicle development. In contrast to previous studies, insulin-stimulating diets during WEI did not improve litter uniformity of embryos or fetuses and placentas in our multiparous sows. These inconsistent effects may be related with differences in sow parity, sow body condition loss during lactation and/or the period of feeding insulin-stimulating diets (lactation and/or WEI) among studies, and thereby differences in plasma IGF-1 levels and follicle development at weaning. These factors need further study.

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