Pork CRC Research Summary

2D-110: Determining the effects of season on ovarian development and early pregnancy returns

Principle Investigator:

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Subprogram 2D: Intervention strategies to reduce seasonal infertility

Background:

Domestic sows commonly experience a depression in fertility during late summer and early autumn. Referred to as seasonal infertility, summer depression of fertility is manifested as a reduced proportion of gilts reaching puberty, extended weaning-oestrus intervals in weaned sows and high anoestrus rates in gilts and sows, as well as increased rates of regular and irregular returns (particularly days 25 – 32 post insemination). While the seasonal effects of photoperiod are relatively well known, growing evidence suggests that exposure to high ambient temperatures and the resultant heat stress negatively affect ovarian function and early embryo development. Betaine, a widely available dietary supplement, acts as a potent organic osmolyte and a major dietary source of the methyl groups required for methionine formation and subsequent DNA methylation. DNA methylation is especially important during embryogenesis. Betaine also acts as an osmoprotectant, increasing the water retention capacity of gut and muscle tissue in pigs, and has the potential to reduce susceptibility to dehydration in response to high ambient temperature, and increase thermotolerance. Therefore, the current study tested two hypotheses:

1. That betaine supplementation of pre-mating diets alleviates the negative impacts of high summer temperatures on ovarian development and reproductive performance
2. That betaine supplementation of gestating sow diets will alleviate the negative effects of high ambient temperature on pregnancy failures and litter size

Methodology

Two studies were conducted in 2007 / 2008. The first study was conducted in winter 2007 and summer 2008, and used 168 gilts to determine the effects of betaine supplementation (2 g / kg feed) from 21 weeks of age until first mating on puberty attainment and potential litter size on day 30 of gestation. Gilts commenced boar exposure at 25 weeks of age and were mated at their first (pubertal) oestrus. Reproductive tracts were collected on day 30 of pregnancy, and the number of corpora lutea and viable embryo's counted. The second study was conducted on a large commercial facility, and determined the effects of supplementing sow gestation diets with betaine during summer on farrowing rates

and litter size. In total, 450 sows (parities 1 to 7) were used in this study. Sows were mated between the 11th of January and 11th February 2008, and received either a standard gestation diet (n = 221) or a betaine supplemented gestation diet (n = 229) for the duration of their pregnancy. All sows were fed at the same level during gestation, with the betaine inclusion rate altered during gestation to ensure a daily intake of between 6.5 and 9.0 g / sow.

Important findings:

The results of study one demonstrate that including betaine in the diets of replacement gilts for 4 weeks prior to, and during, boar exposure, resulted in a 2 day reduction in the interval to puberty (7.5 versus 9.6 days), and an increase in ovulation rate (14.1 versus 13.6) (Figure 1). Comparisons between reproductive performance of gilts mated in the summer and winter also demonstrate a reduction in embryo survival in summer-mated gilts. Interestingly, a significant reduction in both ovulation rate and embryo number was observed when gilts were mated during a period of prolonged high ambient temperature. However, this decrease in ovulation rate was not observed in gilts receiving supplementary betaine prior to mating. The current results indicate that prolonged exposure to high ambient temperature can decrease potential litter size, and suggest that supplementing gilt diets with betaine at 2 g/kg feed prior to mating has the potential to reduce the negative effects of high ambient temperature on reproductive performance of gilts.

The results of study two showed that betaine supplementation of gestation diets increased the total number of piglets born and the number of piglets born alive by 0.6 and 0.5 respectively. Interestingly, the beneficial effect of supplementary betaine was most pronounced in older (parity 3 – 7) sows (Table 1). In addition, supplementing gestation diets with betaine in this experiment also tended to reduce the incidence of late pregnancy loss. Late pregnancy loss is a common manifestation of seasonal infertility, exerting a significant economic impact on breeding herd profitability.

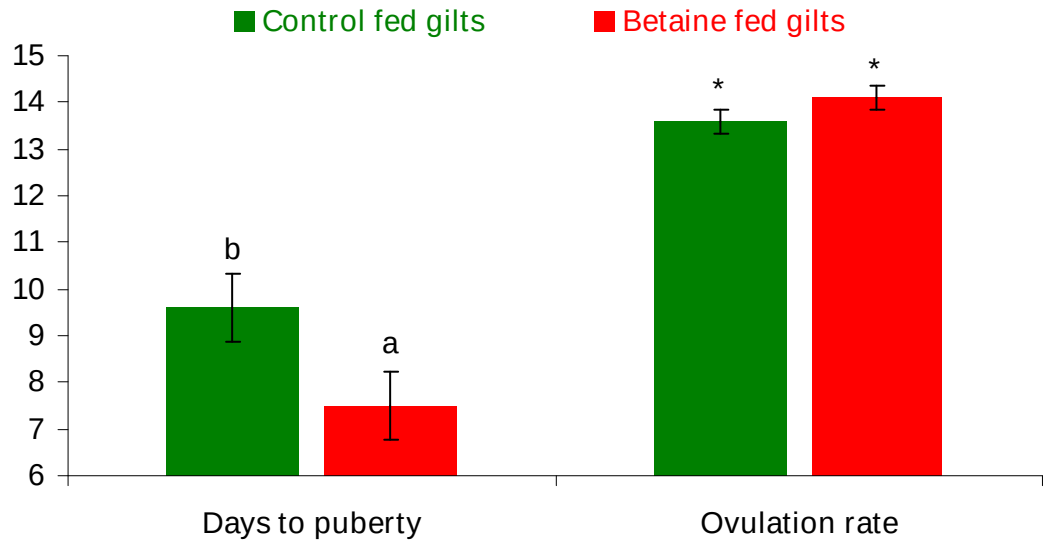

Figure 1 Days to puberty and ovulation rate for gilts fed either a standard (control) or betaine-supplemented diet prior to and during boar exposure [ab] different superscripts indicate significant difference; P < 0.05. * P < 0.1

Table 1 Effect of betaine supplementation in gestation on litter size

	Parity 1 and 2		Parity 3 to 7	
	Control diet	Betaine diet	Control diet	Betaine diet
Total litter size	12.3 ± 0.38[a]	11.9 ± 0.34[a]	12.0 ± 0.30[a]	13.6 ± 0.35[b]
Piglets born alive	11.4 ± 0.33[c]	11.2 ± 0.30[c]	10.8 ± 0.30[c]	12.0 ± 0.30[d]

[ab] within row indicate significant difference; $P < 0.05$. [cd] $P = 0.06$

Summary and conclusions

In conclusion, the current findings demonstrate that adding betaine to the diets of replacement gilts may alleviate the negative effects of heat stress on potential litter size. In addition, it is apparent that supplementary betaine during gestation can increase litter size, particularly in older sows. However, future studies are required to determine the physiological mechanisms mediating the beneficial effects of dietary betaine on reproductive function.

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