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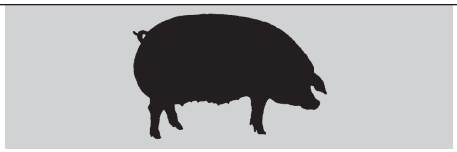

Effect of betaine supplementation during summer on sow lactation and subsequent farrowing performance

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ABSTRACT

The objective of this experiment was to evaluate the effects of betaine supplementation during lactation in hot summer months on piglet growth and sow subsequent reproductive performance. The betaine feeding portion of the experiment was conducted between December 2014 and March 2015 with subsequent litter data completed by July 2015 in Rancagua, Chile. Dietary treatments were allotted randomly to concurrent farrowing rooms of sows. Sows were fed diets supplemented with either 0% (n = 193) or 0.3% (n = 175 sows) of betaine-HCl (70.7% betaine) from 2 d before their farrowing due date until weaning (average lactation length = 21.0 d). Betaine supplemented sows had 3.90% greater ADFI during lactation than control sows (P = 0.005). Treatments by parity interactions were significant for ADFI and sow BW loss (P = 0.008 and P = 0.005, respectively). Parity 2 sows that received betaine supplementation had greater ADFI (6.89 versus 6.17 kg/d) and 6.70 kg less BW loss than parity 2 control sows (P < 0.001 and P = 0.022, respectively). Wean-to-estrus intervals were 0.31 d shorter for betaine supplemented sows than control sows (P = 0.004). There were shifts in the distribution of wean-to-estrus intervals between sows fed control and betaine supplemented diets (P = 0.029). No treatment differences were found for subsequent total born, born alive, conception, and farrowing rate (P = 0.64, P = 0.29, P = 0.83, and P = 0.68, respectively). Betaine supplementation increased daily feed intake and reduced wean-to-estrus intervals during summer months in sows.

Key words: sow, lactation, betaine, wean-to-estrus interval

INTRODUCTION

Sows are increasingly susceptible to heat stress when temperature increase above 25°C (Louis-Sylvestre et al., 1997; Quiniou and Noblet, 1999). Greater than 60% of sow farms in the United States have reported a reduction in fertility during summer months—July and August (Knox et al., 2013). Daily ME intakes during lactation are reduced by 1.6% for each degree Celsius increase in temperature over 22°C and are decreased by 3.64% for each degree Celsius increase in temperature over 25°C (NRC, 2012). Furthermore, selection for increased litter size and milk production has increased the heat production of sows (Stinn and Xin, 2014), reduced the upper critical temperature, and made the sows more sensitive to high environmental temperatures (Quiniou and Noblet, 1999).

Dietary betaine supplementation has been shown to enhance reproductive performance in sows, when betaine was supplemented during gestation (van Wettere et al., 2012) or lactation (Ramis et al., 2011). Dietary betaine may reduce the effect of heat stress on lactating sows through several biological effects.

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Betaine is a tri-methyl derivative of glycine, which is synthesized after 2 oxidation reactions from choline. Betaine acts as an osmoprotectant by increasing water retention capacity in cells, due to its high solubility and dipolar zwitterion characteristics (Chambers and Kunin, 1985; Eklund et al., 2005). During heat stress, epinephrine plasma level concentration is increased and stimulates the Na^+/K^+ ATPase activity, which requires a substantial amount of ATP (Gaffin and Hubbard, 1996). Betaine can improve ionic pump function in the cells (Kidd et al., 1997; Moeckel et al., 2002). The spared energy can be used for other purposes such as maintenance, follicle growth, and milk production.

Betaine has a relevant role in the conversion of homocysteine into methionine (Kidd et al., 1997). In boars, homocysteine serum levels have been reduced with dietary betaine supplementation (Cabezón et al., 2016b). High levels of homocysteine have been associated with defective implantation and early pregnancy failure in women (Holmes, 2003).

The objective of this experiment was to evaluate the effects of betaine supplementation during summer on sow lactation and subsequent reproductive performance.

MATERIALS AND METHODS

Animals, Housing, and Treatments Groups

Animal procedures were consistent with the *Guide for the Care and Use of Animals in Agricultural Research and Teaching* (FASS, 2010). The study was conducted at a commercial, naturally ventilated farrowing facility located in Rancagua, Chile. The experiment was performed from December 15, 2014, to July 31, 2015, in a Mediterranean climate region, classified as Csb (Köppen, 1948). The farm was located in the foothills region of the Andes Mountains at 641 m of altitude.

Sows from 10 farrowing rooms (18.75 × 8.15 × 2.15 m), each with 20 farrowing crates (2.2 × 1.66 m), were used during 3 cycles per room. To remove the effect of low and high born alive, sows with 9 or less and 17 or more born alive were deleted. The same method of editing was performed based on the number of piglets allowed to nurse each sow. After editing, data from 368 sows were analyzed. This included 86 parity 1, 75 parity 2, 164 parity 3 to 5, and 43 parity 6+ sows and 2 genetic lines, 191 PIC C-22 and 177 L-42 sows. Betaine or control diets were fed during 14 wk of summer (December 15, 2014, to March 24, 2015). Dietary treatments were allotted randomly to concurrent farrowing rooms of sows. Sows were fed diets with either 0% (193 sows) or 0.3% (175 sows) of betaine product (93% betaine-HCl with 70.7% pure betaine; Beta-Key, Excentials, Werkendam, the Netherlands) inclusion in their diets (approximately 13.8 g/d of betaine) from 2 d before farrowing due date until weaning. During lactation sows were fed corn–soybean based diets, with 10% sorghum inclusion (Table 1). According to the NRC (2012), the choline concentrations of corn, soybean meal, and sorghum are 0.62, 2.73, and 0.68 g/kg, respectively. The total choline content of the lactation diet was 1.3 g/kg, which exceeded the NRC (2012) requirement of 1 g/kg. Betaine was included in the diet at the expense of corn and was added and mixed into the diet at the feed mill.

Sows were fed 2.1 kg/d with a diet containing 16.2% NDF during gestation. Daily feed intake was increased 0.5 kg/d during the last third of gestation only in sows with a BCS of 3 or less. Sows were fed twice per day (3 kg each) the 2 d before farrowing. After farrowing, sows were fed to achieve ad libitum feed intake by feeding 3 times per day.

Temperature, relative humidity, and dew point measurements were recorded every 5 min with a logger device (EL-USB-2, DATAQ Instruments Inc., Akron, OH) in each farrowing room to develop daily 24-h environmental profiles. Ten loggers, one in each room, were placed at 0.9 m from the floor at the level of sows, away from water sources and air currents. The loggers were activated when sows were moved to the farrowing room and were deactivated at weaning. The thermal humidity index was calculated with the equation described in previous studies (Thom, 1958; Buffington et al., 1981).

Estrus detection was performed every morning using fence-line boar exposure and backpressure test on sows beginning at d 3 after weaning. Post-cervical AI was used in all sows; most sows received 2 doses of semen within a 24-h interval. Each dose contained 2.2×10^9 total spermatozoa. Semen was collected from a boar stud located approximately 27 km from the sow facility, owned by the same company. At d 30 of gestation, an ultrasound pregnancy checking device with

Table 1. Calculated nutrient composition of the basal corn–soybean meal based lactation diet[1]

Component	Basal lactation diet
ME, Mcal/kg	3.32
NE, Mcal/kg	2.43
Humidity, %	10.96
Ash, %	2.98
CP, %	20.04
Crude fiber, %	2.37
Ether extract, %	6.68
Nitrogen-free extract, %	53.04
NDF, %	9.44
SID Lys, %	1.10
SID Met + Cys:Lys	0.55
Choline, mg/kg	750.00

[1]For the betaine diet the basal lactation diet was supplemented with betaine-HCl (3 g/kg) by adding 3 kg/t of Beta Key (70.7% pure betaine; Excentials, Werkendam, the Netherlands) to replace an equal quantity of corn. The total choline content of the lactation diet was 1.3 g/kg, which exceeded the NRC (2012) requirement of 1 g/kg. SID = standardized ileal digestible.