



Effect of natural betaine on estimates of semen quality in mature AI boars during summer heat stress



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ABSTRACT

This study evaluated the effect of supplemental dietary betaine at three concentrations (0.0%, 0.63% and 1.26%) on semen characteristics, quality and quality after storage on boars. The trial was conducted between 22 July and 1 October 2014 in a boar stud located in Oklahoma. Boars were blocked by age within genetic line and randomly allotted to receive 0% (CON, n (line T) = 22, n (line L) = 10), 0.63% (BET-0.63%, n (line T) = 21, n (line L) = 6) or 1.26% (BET-1.26%, n (line T) = 23, n (line L) = 7). The diets containing betaine were fed over 10 weeks, to ensure supplemental betaine product (96% betaine) daily intakes of 16.34 and 32.68 g, for the BET-0.63% and BET-1.26% diets, respectively. Serum homocysteine concentrations were less for animals with betaine treatments ($P=0.016$). Rectal temperatures of the boars were unaffected by betaine diets. Betaine tended to increase total sperm in the ejaculates when collectively compared with data of the control animals ($P=0.093$). Sperm morphology analysis indicated there was a greater percent of sperm with distal midpiece reflex ($P=0.009$) and tail ($P=0.035$) abnormalities in boars fed the BET-1.26% than boars fed the BET-0.63% diet. Betaine concentration in the seminal plasma was greater in boars with betaine treatments, with animals being fed the 0.63% and 1.26% diets having 59.2% and 54.5% greater betaine concentrations in seminal plasma as compared with boars of the control group ($P=0.046$). In conclusion, betaine supplementation at 0.63% and 1.26% tended to increase sperm concentration in the ejaculates by 6% and 13%, respectively, with no negative impacts on semen quality when 0.63% of betaine was included in the diet.

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1. Introduction

Sows and boars are susceptible to negative impacts from high ambient temperatures and humidity. More than 60% of randomly sampled sow farm operations in the U.S.A. reported a decrease in fertility during the hot sum-

mer months (Knox et al., 2013). This seasonal infertility is the result of stress from increased ambient temperatures above the thermal neutral zone and subsequent metabolic changes. McNitt and First (1970) evaluated heat stress in boars and reported that 72 h of exposure to a 33 °C environmental temperature and 50% relative humidity resulted in a reduced sperm concentration and increased sperm abnormalities in ejaculates. Furthermore, Wettemann et al. (1979), found that boars exposed to 34.5 °C for 8 h each day and 31 °C for 16 h during 11 weeks, had less percent

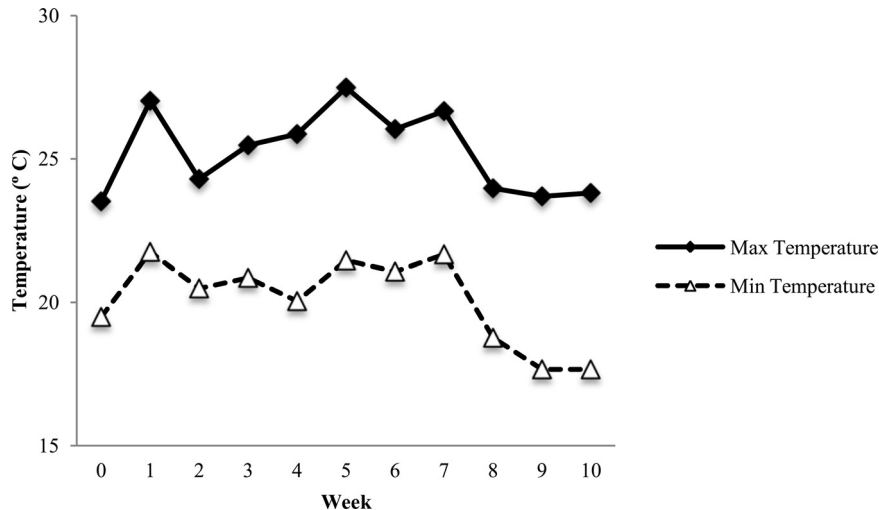
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Table 1

Boar age mean and standard deviation for treatment and genetic lines.

Treatment	Genetic line ^a	Number of boars	Age mean	Age SD
CON	L	10	23.5	15.0
BET 0.63%	L	6	21.0	9.0
BET 1.26%	L	7	19.3	9.1
CON	T	22	22.7	10.3
BET 0.63%	T	21	21.5	9.1
BET 1.26%	T	23	22.9	10.5

^a L: Large White line; T: Terminal line.**Fig. 1.** Mean weekly maximum and minimum temperatures in the housing area during the study, where week 0 started on 13 July 2014.

motile sperm for 5 weeks after heat stress exposure ended in contrast with boars exposed to 23 °C.

Environmental temperatures may not have to greatly exceed the thermal neutral zone to have detrimental effects on reproduction (Flowers, 1997) and the impact of heat stress can vary within and between genetic lines (Flowers, 2008).

Betaine is a methylamine naturally occurring in plant and animal tissues and is also available as a feed additive. A methyl group is donated by betaine to convert homocysteine into methionine (Kidd et al., 1997). Betaine also functions as an osmo-protectant when the animal is stressed by disease, metabolic challenges, or environmental conditions (reviewed by Odle (1995) and Lipinski et al. (2012)) due to its solubility in water and dipolar zwitterion properties (Chambers and Kunin, 1985; Eklund et al., 2005).

van Wettere et al. (2012) provided additional support for the concept that the effects of betaine may be enhanced during times of stress in animals. It was reported that there was an increase in litter size in sows at parity 3 or greater when betaine was supplemented during gestation in the summer months. Additionally, there may be some evidence for enhanced reproductive performance when pregnant sows are supplemented with additional methyl donors (NRC-42, 1976).

A potential explanation for these effects could be the greater ability to regulate homocysteine concentrations in animals treated with betaine. Approximately 18% of men

seeking medical treatment for infertility have a mutation in the enzyme methylenetetrahydrofolate reductase (MTHFR, Bezold et al., 2001), which increases homocysteine concentrations. Knockout mice deficient in the MTHFR enzyme have elevated homocysteine concentrations, oligospermia and infertility. When betaine was supplemented to the mothers of MTHFR knockout mice during gestation and lactation, male offspring had a short-term improvement in fertility (Kelly et al., 2005). When the MTHFR knockout males were fed betaine following weaning, fertility improved. Feeding supplemental betaine to rabbit bucks during the period of summer seasonal infertility resulted in increased sperm concentrations, sperm motility, and ejaculate volume (Hassan et al., 2012). Collectively, these studies suggest that dietary betaine supplementation may improve reproductive performance in males, especially during summer infertility. To our knowledge, no research has been performed to evaluate the impact of betaine supplementation on boar reproduction during times of heat stress. The objective of this trial was, therefore, to assess the effects of betaine supplementation on boar sperm characteristics and number during the summer months.

2. Materials and methods

The Purdue University Institutional Animal Care and Use Committee approved all procedures involving animals.

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