

How over conditioning influences bull fertility

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Sire over-conditioning is a common phenotype observed in the beef industry. Pre- and post-weaning growth are important for profitability; therefore, as an industry, we are interested in identifying bulls with superior genetics for weaning and yearling weights. Nevertheless, young bulls are often not only fed high-energy diets to express their genetic potential at the time of yearling weight collection but also fed these diets to “look good” at sale time. Several Extension programs and bull development stations across the U.S. have reported the general preference of bull buyers for bulls with high rates of average daily gain (ADG) during their growth and development phase. In fact, bull buyers prioritize growth-related traits versus feed efficiency traits such as feed-to-gain ratio (F:G) or residual feed intake (RFI; Oosthuizen et al., 2018).

Another factor that encourages seedstock producers to increase energy intake during sire development is the effect of these dietary strategies on pubertal development. Similar to what has been thoroughly shown in heifers, sires that are exposed to high-energy diets achieve puberty earlier (Cardoso et al., 2018; Kenny and Byrne, 2018). Yet, most bulls from British breeds reach puberty prior to or around the time of yearling weight assessments, and continuing to feed bulls high energy diets later in development has minor effects on advancing puberty (Byrne et al., 2018).

While over conditioned bulls are attractive to bull buyers, studies show that extreme over conditioning has negative consequences to semen quality. When a study evaluated 1,635 breeding soundness examination (BSE) records of beef bulls, only 45% of the extremely over-conditioned bulls (body condition score ≥ 4 using a 1 to 5 scale) passed the BSE, whereas 81% of bulls with adequate body condition scores (body condition score = 3 using a 1 to 5 scale) passed the BSE (Barth and Waldner, 2002). A separate study evaluating the impact of feeding young bulls a moderate-gain diet primarily comprised of forage (Control) versus a high-energy diet consisting of 80% concentrate and 20% forage (High Gain) observed similar results (Coulter et al., 1997). After a 168-day feeding period, bulls fed to the High Gain diets were heavier and had greater backfat thickness compared with Control bulls. In addition, bulls in the High Gain diet had a greater percentage of secondary sperm defects (28.7% vs. 9.9%) and decreased average sperm motility (44.5% vs. 53.4%) compared to Control bulls (**Figure 1.A**). Moreover, the High Gain bulls also had greater scrotal circumference and decreased changes in scrotal surface temperature gradient (measured with infrared camera; **Figure 1.B**) from the top portion of the scrotum to the bottom portion. This data indicates that High Gain bulls may have experienced impaired testicular thermoregulation, potentially associated with increased fat deposition in the neck region of the scrotum, which could explain the decrease in semen quality.

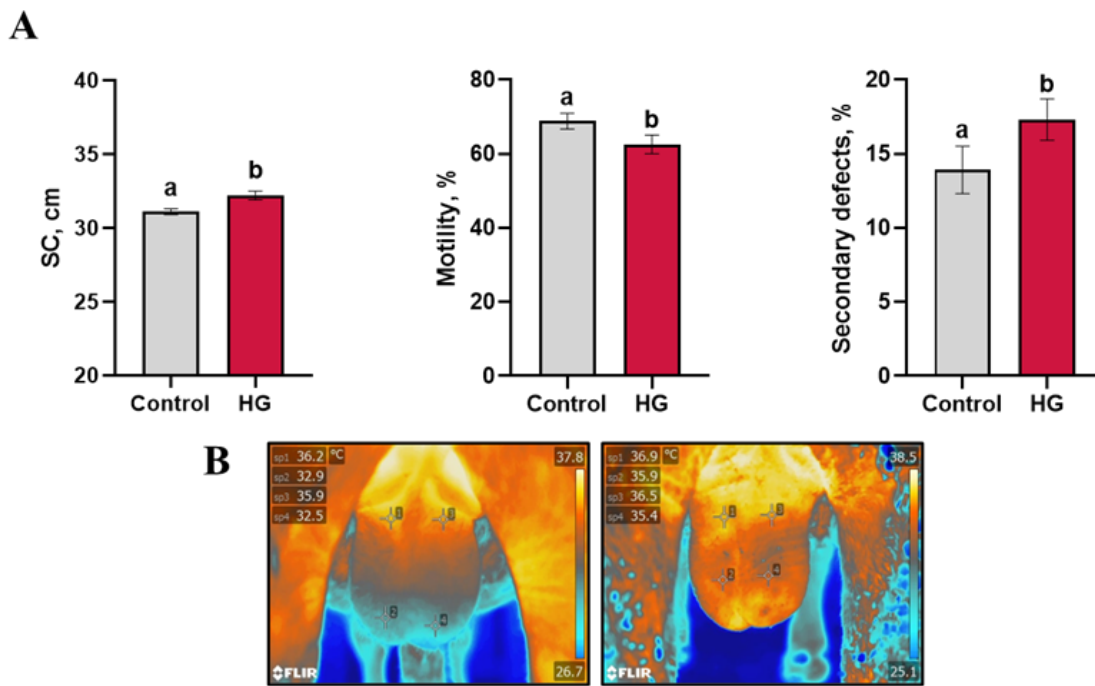


Figure 1. A) Effect of inclusion of high-gain diets for young bulls and its impact on scrotal circumference, sperm progressive motility, and sperm secondary defects. Adapted from: Coulter et al., (1997). **B)** Representative photos of infrared thermal imaging of the scrotum with different gradients of scrotal surface in young beef bulls.

Currently, our group has focused on utilizing new technologies (computer assisted sperm analysis, flow cytometry, and others) to further understand the impact high energy diets on the fertility of beef bulls. Moreover, we are currently investigating the consequences of these diets to embryo development and pregnancy establishment. In a recent study (Seekford et al., 2023), mature bulls that had previously passed a breeding soundness examination were randomly assigned to either receive a diet designed for a target average daily gain (ADG) of 4 lbs/d (High Gain) or a diet designed to maintain body weight (Control). Bulls were fed individually their respective diets for 67 days and semen was collected and frozen at the end of the feeding period. Semen was then utilized to produce embryos in vitro. In humans, studies have shown that couples that undergo in vitro fertilization (IVF) have decreased chances of becoming pregnant when the male partner is overweight. Our results indicate that the same occurs in beef bulls. The percentage of embryos produced relative to the number of oocytes (female eggs) tended to be decreased in High Gain compared with Control bulls. Moreover, the percentage of embryos produced relative to the number of cleaved oocytes (oocytes that had undergone fertilization and started to undergo cell division) was reduced when semen from High Gain compared with semen from Control bulls were utilized (**Figure 2**). These results indicate that highly anabolic conditions not only influence sperm motility and morphology but also induce negative post-fertilization changes in embryo development in cattle.

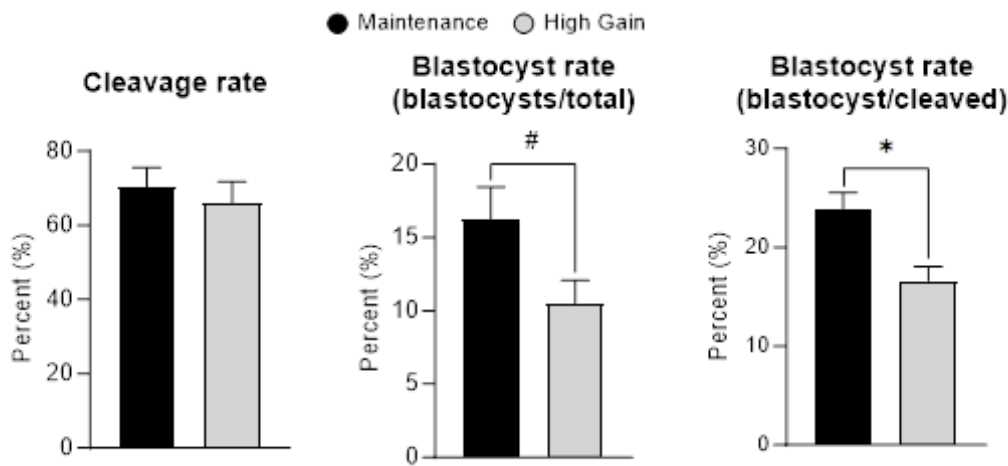


Figure 2. Effect of sire diet on in vitro embryo production. Different superscripts indicate statistical difference (* $P < 0.05$) or tendency ($\#P < 0.10$). Cleavage rates represent the number of oocytes (female eggs) that started to develop into embryos after being exposed to semen. Blastocyst rate represents the percentage of embryos produced relative to the number of oocytes (middle panel) or relative to the number of cleaved oocytes (right panel). Adapted from Seekford et al., (2023).

In summary, studies indicate that over conditioning has not only negative effects on semen quality but also negatively impacts embryo development after fertilization occurs. Therefore, while high energy diets can be utilized to allow young bulls to express the genetic potential for post-weaning growth, producers should be cautious to avoid excessively feeding bulls to an extent that fertility is compromised. Feeding bulls to maintain body condition score of 6 (using a 1 to 9 scale) is ideal. This will allow bulls to have enough energy reserves to withstand an active breeding season while also minimizing their chances of having decreased fertility associated with over conditioning.

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