

# Meat Science and Muscle Biology Symposium: Implants, Muscle Development and Meat Quality

**359 Cattle implants: Past and future.** S. K. Duckett\* and S. L. Pratt, *Clemson University, Clemson, SC.*

Anabolic implants are routinely used in the finishing phase of beef production to improve animal performance and feed efficiency. Implanting during the feedlot phase on average increases ADG 18%, feed intake 6%, feed efficiency 8%, carcass weight 5% and ribeye area 4% compared with non-implanted controls. Implants reduce the cost of beef production, which is important given current high feed costs and beef prices. In a 1996 review of 37 implant trials, the use of a combination (estrogenic and trenbolone acetate) implant increased returns by \$77 per hd compared with non-implanted steers. If calculated in today's prices, a combination implant would increase returns by \$163 per hd. However, concerns about potential negative effects of implants on marbling scores, quality grades, and tenderness exist. Changes in Warner-Bratzler shear force values of steaks from implanted steers are small (<0.5 kg) and appear related to an increase in initial tenderness, possibly due to hypertrophy of muscle fiber, instead of alterations in postmortem proteolysis. The increase in ribeye size observed with implanting may also reduce marbling scores through a dilution effect. The effect of anabolic implants on gene expression has shown that implanting downregulates certain lipogenic (SCD-1, FASN, ELOVL6) genes in steers with low quality grades (Select-) but not in implanted steers with high quality grades (Choice-). Examination of the adipocyte's transcriptome has shown that 36 genes were differentially expressed due to implant treatment. More research is needed to further determine how anabolic implants alter lipogenic gene expression to address changes in marbling deposition with implant usage. Given our current high feed costs and cattle prices, anabolic implants are one of the most cost effective technologies that can be utilized in beef production systems.

**Key Words:** beef, implant

**360 Implant and beta agonists affect beef palatability.** M. F. Miller\* and A. J. Garmyn, *Texas Tech University, Lubbock.*

The use of anabolic implants has a long-standing place in the cattle feeding industry, due their positive effect on growth performance and subsequent profitability. However, implants can have adverse effects on carcass quality, shear force, and eating quality based on the dose and frequency of administration, or what some may refer to as the aggressiveness of the implant regimen. Within the past decade, a new class of growth promotants – known as  $\beta$ -adrenergic agonists ( $\beta$ AA) – has emerged in the beef feeding industry. Currently, 2 have gained FDA approval for use in beef finishing diets to improve performance and yield. Much like anabolic implants, these repartitioning agents can have negative effects on Warner-Bratzler shear force (WBSF), but the differences do not translate directly to consumer responses for palatability and acceptance in some instances, especially when tenderness is managed through postmortem aging. As researchers continued to investigate the mechanisms driving  $\beta$ AA, inevitably this led to consideration of the interaction between  $\beta$ AA and anabolic implants. Early work combining zilpaterol hydrochloride (ZH) with anabolic implants improved performance and carcass yield with additive negative effects on WBSF. Similar results were produced when pairing ZH with anabolic steroids equipped with various release patterns. As with any tool, the key to success is proper management. Certain cattle populations may be better suited to receive growth promotants such as implants and  $\beta$ AA, and

postmortem management of subprimals becomes vital when producers take more aggressive approaches to improve performance and yield. The objective of this review is to overview research findings related to the effect of growth promotant technologies on beef palatability, focusing specifically on the role of implants and  $\beta$  adrenergic agonists on beef tenderness and consumer palatability.

**Key Words:**  $\beta$ -agonist, implant, palatability

**361 Mechanisms of growth hormone and IGF-I stimulation of skeletal muscle growth in cattle.** H. Jiang\* and X. Ge, *Virginia Polytechnic Institute and State University, Blacksburg.*

Both growth hormone (GH) and IGF-I have growth-promoting effects on skeletal muscle. We conducted 2 studies to understand the mechanisms by which GH and IGF-I stimulate skeletal muscle growth in cattle. In the first study, we determined whether GH stimulates skeletal muscle growth in cattle through IGF-I produced in skeletal muscle. We isolated satellite cells from adult cattle and allowed them to proliferate as myoblasts or induced them to differentiate into myotubes. Addition of GH to the culture medium increased protein synthesis but had no effect on protein degradation or myoblast proliferation. Addition of IGF-I to the culture medium stimulated protein synthesis, and this effect was much greater than that of GH. Addition of IGF-I to the culture medium also inhibited protein degradation and stimulated myoblast proliferation. Neither GH nor IGF-I affected myoblast differentiation into myotubes. We also observed that GH had no effect on IGF-I mRNA expression in bovine muscle cells and that GH administration to cattle did not alter IGF-I mRNA expression in skeletal muscle while increasing IGF-I mRNA expression in liver and IGF-I concentration in blood. These data together suggest that GH and IGF-I have largely different effects on bovine skeletal muscle cells and that the growth-promoting effect of GH on skeletal muscle is unlikely mediated through locally produced IGF-I. In the second study, we determined the signaling pathways that mediate the different effects of IGF-I on bovine muscle cells using the PI3K inhibitor LY294002, the ERK inhibitor PD98059, and the mTOR inhibitor rapamycin. Our data suggest that both the MEK/ERK and PI3K/AKT pathways mediate the stimulatory effect of IGF-I on bovine myoblast proliferation. We also identified cyclin D2 as a downstream component of the PI3K/AKT pathway that mediates the stimulatory effect of IGF-I on bovine myoblast proliferation. Our data suggest that both the MEK/ERK and PI3K/AKT pathways mediate the stimulatory effect of IGF-I on protein synthesis in bovine myotubes through p70S6K and that the PI3K/AKT pathway mediates the inhibitory effect of IGF-I on protein degradation through FoxO3a.

**Key Words:** growth hormone, IGF-I, muscle

**362 Role of satellite cells in anabolic steroid-enhanced muscle growth in feedlot steers.** W. R. Dayton\* and M. E. White, *University of Minnesota, St. Paul.*

Androgenic and estrogenic anabolic steroid implants are widely used to enhance rate and efficiency of muscle growth in feedlot cattle. Although the mechanism of action of these compounds is not known, recent studies indicate that their effects on muscle satellite cells (MSC) play a central role. Treatment of steers with a combined estradiol (E2)/

trenbolone acetate (TBA) implant results in a 2-fold increase ( $P < 0.05$ ) in the number of MSC that can be isolated from the longissimus dorsi muscle. This is significant because satellite cells are the source of nuclei needed to support postnatal muscle fiber hypertrophy and are thus crucial in determining the rate and extent of muscle growth. Implantation with E2 /TBA increases the levels of circulating IGF-1 ( $P < 0.05$ ) and results in a 3-fold increase in muscle IGF-1 mRNA level ( $P < 0.05$ ). Thus, IGF-1 may play a role in the increased satellite cell number observed in implanted steers. To further explore the role of satellite cells in the mechanism of anabolic steroid-enhanced muscle growth, we have examined the effects E2 and TBA on cultured bovine satellite cells (BSC). Both E2 and TBA stimulate IGF-1 mRNA expression in cultured BSC ( $P < 0.05$ ). Interestingly, E2 stimulates IGF-1 expression

through binding to the G protein-coupled estrogen receptor (GPER-1) rather than through interaction with the classical estrogen receptors. Even under culture conditions in which IGF-1 expression levels are not increased, treatment with E2 or TBA stimulates proliferation and protein synthesis and inhibits protein degradation in cultured BSC, suggesting that both E2 and TBA can affect satellite cells via mechanisms that do not involve increased IGF-1 expression. Studies utilizing siRNA silencing and specific receptor tyrosine kinase inhibitors suggest that estrogen receptor- $\alpha$ , GPER-1, insulin-like growth factor receptor-1 and the epidermal growth factor receptor may play roles in the effects of E2 on proliferation, protein synthesis and protein degradation in cultured BSC.

**Key Words:** anabolic steroid, satellite cell