Growth promotants have been widely used in beef production to dramatically improve production efficiency, including improvements in ADG, feed efficiency, carcass weight, and lean to fat ratio. The average economic return due to implant of steroid growth promotants is estimated to be around $100/head. However, these promotants may have negative effects on beef quality, including a reduction in marbling score and tenderness. The effects of growth promotants on beef cattle production, lean growth, and meat quality have been studied extensively. Less studied, however, are the biological mechanisms responsible for the altered traits due to implants.

Broadly, growth promotants include anabolic steroids, β-adrenergic agonists, GH, antimicrobials, and ionophores. Here, we focus only on two major categories, steroids and β-adrenergic agonists, which can directly stimulate muscle growth. Steroidal anabolic growth promotants have been most commonly used, which can be further separated into estrogenic and androgenic growth promotants, as well as their combinations. The biological effects of steroidal growth promotants are mainly mediated by an elevation of local and circulating IFG-1 concentrations in steroid-treated cattle, the activation of steroid receptors and their down-stream signaling pathways, as well as the direct stimulation of G protein-coupled estrogen receptor-1. These changes propel the proliferation and myogenic differentiation of satellite cells, increase protein synthesis, and reduce protein degradation, thereby leading to muscle fiber hypertrophy.

Less studied are the effects of growth promotants on the myogenic differentiation of progenitor cells. Muscle development involves both myogenesis (i.e., formation of myogenic cells and muscle) and adipogenesis (i.e., generation of intramuscular adipocytes for marbling fat accumulation). Both myogenic and adipogenic cells are derived from a common pool of progenitor cells, and steroidal growth promotants likely promote the myogenic differentiation while inhibiting adipogenic differentiation, which should contribute to the enhanced lean growth but reduce marbling in implanted cattle, a field warranting further studies.

In the recent decade, β-adrenergic agonists also have been used increasingly in beef production. Prominent among these agonists is the recently-developed zilpaterol hydrochloride, with several feeding trials conducted during the past several years, which show promising results in the improvement of beef production.

In the symposium titled “Implants, muscle development and meat quality” at the Joint Annual Meeting in Indianapolis, we invited 4 prominent researchers in the field of meat science and muscle biology who work with growth promotants from different perspectives. The objective of this symposium was to provide the audience with both an overview and in-depth information about the application and research progress of growth promotants in beef cattle production, muscle growth, and meat quality.

In the first presentation, S. K. Duckett presented the overall application of anabolic steroid implants in the United States, and their impacts on beef production and meat quality. She discussed that the overall financial returns in beef cattle due to the application of different implant strategies. She also indicated that steroid implants promote muscle growth and alter lipid metabolism, focusing on the changes in adipocyte transcriptomes in implanted cattle. She concluded that anabolic implants are cost effective, especially considering the current high feed costs and cattle prices (Duckett and Pratt, 2014).
In the second presentation, M. F. Miller discussed the effects of β-adrenergic implant in beef production and quality. His talk focuses on zilpaterol hydrochloride, a newly approved β-adrenergic agonist that has received much attention in the last several years. Studies found that zilpaterol hydrochloride improved growth performance, carcass yield, and lean cuts, but had slightly negative effect on beef tenderness (Garymyn and Miller, 2014). Overall, zilpaterol hydrochloride implanting has minor or no effects on consumer acceptance of flavor of the resulting beef.

The third presentation was made by H. Jiang, who discussed the role of IGF-1 in mediating the biological effects of GH. Steroid hormones are known to stimulate the secretion of GH, which in turn promotes IGF-1 synthesis. The biological effect of steroid hormones has been attributed to the enhanced IGF-1 production in both liver and muscle of implanted cattle. In his talk, Dr. Jiang presented data showing that liver IGF-1 production is the major mechanism mediating the growth-stimulatory effect of GH in skeletal muscle of beef cattle (Jiang and Ge, 2014).

The last talk was presented by W. R. Dayton, who discussed the molecular mechanisms leading to the proliferation of satellite cells due to steroid implants in beef cattle (Dayton and White, 2014). Studies in his laboratory found that estradiol and trenbolone increase satellite cell proliferation, which is associated with enhanced IGF-1 secretion. In addition, IGF-1 promotes protein synthesis and decreases protein degradation. Furthermore, he also discussed the involvement of estrogen receptor-α, and the G protein-coupled estrogen receptor-1 in mediating the anabolic effects of estrogenic implants.

These four symposium papers represent several important topics ranging from economic impact of steroidal and β-adrenergic growth promotants in beef production to their molecular mechanisms of action on skeletal muscle, and are not meant to be comprehensive. In fact, due to the limited time allocated to this symposium, we are unable to cover several other equally important topics, such as the differentiation of progenitor cells to myogenic or adipogenic lineages due to use of growth promotants. We hope that this symposium and the corresponding papers will provide readers with an overall picture in the application and research related to beef growth promotants, which will further stimulate discussion and studies in this important area in animal production and meat quality.

LITERATURE CITED