Acta Scientific NUTRITIONAL HEALTH (ISSN:2582-1423)

Volume 4 Issue 11 November 2020

Editorial

Beta-Adrenergic Agonists: Effects on Growth and Characteristics of Meat and Livestock Production

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Received: August 31, 2020

Published: September 30, 2020

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Number of multinucleated cellular units or muscle fibers is fixed at birth. Increasing muscle hypertrophy has been a primary focus of investigators. Beta-adrenergic agonists increase muscle mass by increasing the ratio of protein to deoxyribonucleic acid (DNA), while steroidal implants increase muscle mass by increasing accumulation of DNA in muscle. Beta-adrenergic agonists and steroidal implants have similar physiologic responses of muscle hypertrophy, but have different mechanisms of action to achieve muscle growth. Beta-adrenergic agonists suppress adipose accretion in livestock species. Cattle has more than 99% of beta-2 adrenergic receptor in the skeletal muscle and has more than 90% of beta-2 adrenergic receptor in adipose tissue, whereas pig has 73% of beta-1, 20% of beta-2 and 7% of beta-3 adrenergic receptors.

Synthetic beta-adrenergic agonists have different mechanisms of action, such as propranolol for partial beta-3 receptor of cattle, clenbuterol for partial beta-3 receptor of pigs and beta-2 receptor of cattle, ractopamine for beta-1 and partial beta-2 receptors of pigs, etc. The distribution of different subtypes and the presence of beta-adrenergic receptor in skeletal muscle may be associated with relative maturity of the animals. In a previous study, short-term exposure of isoproterenol did not increase cyclic adenosine monophosphate (cAMP) production indicating the lack of functional beta-adrenergic receptor in fetal skeletal muscle. Nevertheless, small amounts of bet-2-adrenergic-receptor messenger ribonucleic acid (mRNA) were present in the total RNA from these muscle cell cultures. Previous studies on clenbuterol feeding to both young and old rats demonstrated that older and more mature rats were more responsive to clenbuterol administration compared to the younger rats.

Treatment of ractopamine can enhance the protein synthesis of porcine skeletal muscle by increasing myosin heavy-chain protein synthesis, muscle protein accretion, and increasing myofibrillar and total protein synthesis without detectable effect on protein degradation. Both ractopamine and clenbuterol also increase myosin light chain-1 (Type II MLC-1 isoform) mRNA abundance in the lean muscle of beef cattle compared to untreated cattle. Beta-adrenergic agonist-agonist-induced up-regulation of myofibrillar protein gene transcription results in increasing myofibrillar protein synthesis. Increasing mRNA transcription of muscle protein contributes to elevation of muscle hypertrophy, supported by muscle culture studies that beta-adrenergic agonist stimulated protein synthesis. Beta-adrenergic agonist treatment decreased overall meat tenderness, reported in lambs and beef cattle. The muscle protease that regulates protein degradation and are affected *in vivo* frequently follows parallel responses in the postmortem meat. A previous study revealed that at high-dose ractopamine, a presumed beta-1-adrenergic agonist can bind to beta-2-adrenergic receptor and elicit a biological response consistent with that type of receptor. Lo´pez-Carlos., *et al*. concluded that supplementation with beta-adrenergic agonist increased lean muscle fiber diameter of lambs fed zilpaterol hydrochloride (ZH) step-up program that could be unfavorable due to potential negative effect on muscle tenderness. Additionally, their study demonstrated no adverse effects on lean muscle characteristics (chemical composition, pH and moisture loss), organ mass weight, or blood metabolites.

In conclusion, beta-adrenergic agonist treatment is primarily responsible for the increased muscle hypertrophy by elevation of glycolytic muscle fiber types without association with both intramuscular and intermuscular adipose tissue amount. Cattle receiving beta-adrenergic agonist tend to have a lower back-fat thickness, increased beef toughness, and reduced marbling scores. In beta-adrenergic agonist-treated cattle, further urgent studies are needed to enhance growth performance and find possible beta-adrenergic agonist adverse-side effects on pig, beef, and other cattle production.

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