

Project Summary

Feeding Ractopamine Hydrochloride to Cull Cows II: Effects on Carcass Composition, Yield, Warner–Bratzler Shear Force and Muscle Histology Traits

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Background

Feeding cows culled from the breeding herd prior to harvest is a common beef industry practice. Cows with a higher body composition score, and thus weight, optimize economic return through both a higher carcass value and a higher live value. Recently, the Food and Drug Administration (FDA) has approved a beta-agonist (Optaflexx™ 45; ractopamine hydrochloride) for use in feedlot cattle to increase lean meat yield when fed during the final 28 to 42 days of feeding. Previous studies have shown that inclusion of Optaflexx™ in the diet for the last 30 days of feeding increases lean muscle deposition while decreasing fat deposition for the final feeding period, producing a higher red meat yield in beef steers and heifers. However, limited research has observed if providing Optaflexx™ during the last 30 days of feeding will increase the lean meat yield and meat quality effects on the physical characteristics of muscles from cull beef cows. Additionally, few studies address the cellular aspects of muscle fiber hypertrophy and presence of satellite cells as a mechanism of increasing lean meat yield.

The objectives of this project were to:

1. Determine if providing Optaflexx™ during the last 30 days of a 50 day feeding period increases the lean meat yield of cull cows.
2. Determine meat quality effects on the physical characteristics of key muscles from cull beef cows.
3. Determine if increases in the lean meat yield of four selected muscles results from increases of muscle fiber cross-sectional area, diameter and satellite cell numbers.
4. Determine if Optaflexx™ affects the mRNA expression of the beta-adrenergic receptors, calpains and calpastatin in the *semimembranosus* and *longissimus dorsi* muscles.

Methodology

A total of 98 culled beef cows representing two different breed types were transported to a feeding facility in Florida with the exception of the baseline group, which was harvested on day one. The cows designated for feeding were randomly sorted based on breed type and fed a concentrate diet in one of four pens for 54 days and assigned to one of four treatment groups – control fed, Optaflexx™ at 100 mg/hd/day, Optaflexx™ at 200 mg/hd/day and Optaflexx™ at 300 mg/hd/day. Experimental groups received Optaflexx™ during the last 30 days of the 54 day feeding trial. Immediately following harvest, portions of the *longissimus dorsi* and *semimembranosus* muscles from four randomly selected animals per group were collected and frozen in liquid nitrogen for RNA extraction.

At 24 hours post-harvest, the carcasses were fabricated and nine muscles (*adductor*, *gracilis*, *infraspinatus*, *longissimus dorsi*, *rectus femoris*, *semimembranosus*, *teres major*, *triceps brachii*, and *vastus lateralis*) were removed along with the 9-10-11 rib section. Muscles were wet aged for 14 days and one frozen before one inch steaks were cut from the anterior end of each for Warner-Bratzler shear force determination. Ether extraction was performed on the 9-10-11 rib section to estimate compositional changes of the carcass and ether extraction was performed on

the *longissimus dorsi* to determine percent intramuscular fat. Samples were also collected for muscle fiber area and diameter measurements, myosin heavy chain analysis, total number of fiber associated nuclei, and RNA extraction.

Phase I Findings

Carcass composition and yield measurements

Hot carcass weights tended to be heavier for the control fed group compared to the 100 and 200 mg/hd/day treatments. Dressing percentage was also higher for the control fed group in comparison to the 200 mg/hd/day treatment. Beef cull cows fed Optaflexx™ for the last 30 days of feeding significantly increased the denuded weight of all muscles studied except for the *teres major*. Optaflexx™ had the greatest effect on the *semimembranosus* muscle. No muscles changed in weight on a percentage basis revealing that initial commodity weight differences observed were due to heavier hot carcass weights within treatments.

Ribeye area tended to be larger for the 300 mg/hd/day and control fed group compared to the 200 mg/hd/day treatment. Utilizing ribeye area on a hot carcass weight basis as an indicator of carcass muscling the 300 mg/hd/day treatment was heavy muscled for its hot carcass weight, while the control fed and 100 mg/hd/day treatments were average muscled and the 200 mg/hd/day treatment was light muscled for its hot carcass weight.

The 300 mg/hd/day treatment group was 6.3% higher in fat free lean compared to the control fed group while the 100 and 200 mg/hd/day treatments were intermediates of the control fed and 300 mg/hd/day treatments. This demonstrates that at the higher fed levels of Optaflexx™, lean accretion is generated at a faster rate than fat deposition. Percent intramuscular fat was not significantly different among the treatment groups illustrating that Optaflexx™ has more of an effect on subcutaneous and intermuscular fat than intramuscular fat (marbling).

Warner-Bratzler shear force data reveals that Optaflexx™ affects muscles individually and inconsistently. The infraspinatus decreased in tenderness with Optaflexx™ treatment compared to the control fed group. In contrast, the *semimembranosus* increased in tenderness at 100 mg/hd/day compared to the control fed group. These findings lead to the second phase of this study.

Phase II Findings

Immunohistochemistry

The type I fibers of the *infraspinatus* and *vastus lateralis* muscles increased in cross-sectional area and diameter, while the *longissimus dorsi* and *semimembranosus* did not respond to Optaflexx™ supplementation. Type I fiber diameters for each of the treatment groups followed the same trends as the type I fiber cross-sectional area data due to the high correlation between fiber diameter and cross-sectional area. The type II fibers of the infraspinatus tended to increase in cross-sectional area and diameter. Ractopamine hydrochloride included in the diet increased cross-sectional area of type II fibers of the infraspinatus muscle in a similar manner as type I fibers. Means of diameters of the four treatment groups were not different. The lack of effect of ractopamine hydrochloride on whole muscle parameters is due to the inability of ractopamine hydrochloride to stimulate increases in muscle fiber cross-sectional area and diameter. When increases in fiber cross-sectional area occurred, only one fiber type was affected or increases in

cross-sectional area were minimal. Therefore, these increases were not enough to cause increases at the whole muscle level.

Ractopamine hydrochloride shifted the percentage of type I to type II fibers in the *longissimus dorsi*, *semimembranosus* and *vastus lateralis* muscles. The exception in these three muscles resulted from the 100 mg/hd/day treatment group shifting the percentage of fibers from type II to type I. The infraspinatus muscle also had a significant shift in fibers from type II to type I, with the exception of the 100 mg/hd/day treatment group which experienced an opposite shift in fiber type. Reasons for these shifts are unknown and warrant further research.

Postnatal skeletal growth is accomplished through satellite cell population. Satellite cells counted per one hundred fibers was measured as an index of muscle fiber hypertrophy. For all muscles, level of ractopamine hydrochloride supplementation did not affect satellite cells detected by immunohistochemistry. Since supplementation did not increase the detection of satellite cells, researchers hypothesized altering of protein synthesis/degradation rate caused the modest increase in fiber cross-sectional area seen in this study.

Real-time PCR analysis

Real-time PCR analysis evaluated mRNA levels of beta1- and beta2-adrenergic receptor, μ - and m-calpain and calpastatin. The present study was unable to detect measurable levels of the beta1-adrenergic receptor by real-time PCR analysis but was able to detect by end-point PCR analysis. This could be due to faint levels of mRNA expressed in the muscle. For all other genes of interest analyzed by real-time PCR analysis, treatment did not have an effect on mRNA expression.

Implications

Optaflexx™ fed cow carcasses had on average 4.4% more fat-free lean than control fed carcasses. In addition, feeding Optaflexx™ had little or no significant effect on Warner-Bratzler shear values of eight of the nine muscles evaluated. In conclusion, feeding Optaflexx™ did increase fat-free lean of the carcass with little negative effect on meat tenderness characteristics.

The lack of response of measured muscle parameters was due to the inability of Optaflexx™ to cause substantial increases in the cross-sectional areas and diameters of both type I and type II fibers. Supplementation of Optaflexx™ did not affect the number of satellite cells counted per 100 fibers. This indicates that the mechanism of growth seen in the affected type I and type II fibers was due to the changes in muscle synthesis rate. Real-time PCR analysis found that the beta2-adrenergic receptor is the primary receptor subtype in aged cull cows. The probable cause of the minimal response in muscle growth to Optaflexx™ supplementation was probably due to the inability of old cattle to have a high protein synthesis rate.

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