Influence of Ceftiofur Sodium Bio-Bullet Administration on Tenderness and Tissue Damage in Beef Round Muscle

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Story in Brief

Steer (n=25) calves were individually identified and assigned randomly to a product administration treatment date (7, 14, 21, 28 or 35 d prior to harvest). The product administered in the trial was a standard bio-bullet containing .0035 oz of freeze-dried ceftiofur sodium. At each product administration time, five steers were identified and placed into a standard commercial restraining chute. The bio-bullet implant was administered from a distance of 20 ft. Upon completion of the finishing period, steers were humanely harvested, carcasses were fabricated, and Oklahoma State University personnel collected the treated (i.e., left) bottom round flats from each of the carcasses. Additionally, the opposite paired bottom round flat from each of the carcasses from steers that received a bio-bullet either 7, 14 or 21 d prior to harvest was collected. The round samples were then stored for 14 d. At the conclusion of the storage period, each flat was dissected into .5 in strips followed by observation and palpation for the presence of injection-site lesions. A number of steaks from treated animals (n=15; 5 each from 7, 14 and 21 d pre-harvest administered samples) and their control paired counterparts were collected and Warner-Bratzler shear force values measurements were obtained for each sample as a prediction of tenderness. Visible tissue damage was only observed in cattle that were treated either 7 d or 14 d prior to harvest. Even in the muscle samples containing visible tissue damage, cooked tenderness ratings were the same compared to their paired control counterparts.

Key Words: Injection-site lesions, Implants, Pharmaceuticals, Beef

Introduction

Damaged beef muscle tissue resulting from intramuscular injections of animal-health products represents a “quality control” problem and an economic loss to the beef industry. Results of the National Beef Quality Audit – 2000 (Smith et al., 2000) revealed that beef packers believed that the greatest quality improvement since 1991 has been the reduced frequency of injection-site lesions found in beef top sirloin subprimals. National audits conducted by the National Cattlemen’s Beef Association (NCBA) and its Quality Assurance Advisory Board have revealed a reduction in the incidence of injection-site lesions from 21.3% (July 1991) to 10.9% (March 1993). As a result of changed injection practices and continued educational efforts, the incidence of injection-site lesion defects in top sirloins is at a record low of 2.1% (Roeber et al., 2001). Even with such improvement, purveyors and retailers still ranked this defect among the top 10 challenges of fed steers and heifers.

Pharmaceuticals are commonly administered to cattle at various stages of their lives (Taylor and Field, 1999). If injections are given intramuscularly, tissue damage occurs (George et al., 1995). With that in mind, the recommendation of the NCBA has been the strong encouragement that subcutaneous injections be administered when allowable. This issued recommendation is certainly not a major obstacle for most pharmaceutical products under structured situations such

as feedlot production situations. However, treating cattle in an open pasture situation lends to potential problems such as the stress of being held from the herd as well as unwanted restraint techniques.

Until recently, administering biologicals and pharmaceuticals to animals has meant needles and syringes. A relatively new company, Ballistic Technologies Inc., has devised a method that uses an air-powered system to deliver biodegradable implants containing freeze-dried products. The "bio-bullets" penetrate into the animal's muscle and begin to be absorbed in the animal's body. The questions that had to be addressed were very simple: 1) Does the bio-bullet technology pose a quality control problem by creating injection-site lesions, 2) What impact – if any -- does the bio-bullet have on any pathological changes of beef round muscle, and 3) If bio-bullets create injection-site lesions, what influence does this potentially have on cooked beef tenderness?

Materials and Methods

Steer (n=25) calves, of known history, located at the Willard Sparks Beef Cattle Research Facility, Oklahoma State University, were selected for use in the present study. These calves had received no injections in the round before the beginning of the trial and were individually identified and assigned randomly to a product administration treatment date (7, 14, 21, 28 or 35 d prior to harvest).

The product administered in the trial was a standard bio-bullet containing .0035 oz of freeze-dried ceftiofur sodium. At each product administration time, five steers were identified and placed into a standard commercial restraining chute. For the cattle administered with the bio-bullet at 7, 14, 21 or 28 d prior to harvest, a 4 x 4 in patch was shaven free of hair on the left round of each animal. This location would correspond to a location directly over the biceps femoris muscle. After highlighting the targeted administration area, the bio-bullet implant was administered by a trained Ballistic Technologies, Inc representative from a distance of 20 ft. It should be mentioned that all 25 animals received their respective bio-bullet implant in the targeted location. However, it should be noted that the cattle that were processed in the initial administration time (i.e., 35 d prior to harvest) received the bio-bullet injection prior to shaving the hair from outer round area. On this particular set of cattle (n=5), a 4 x 4 in shaven area was performed following the bio-bullet injection to insure that the injection entry location was isolated and identified. Thus, at each of the administration times (i.e., 7, 14, 21, 28 or 35 d prior to harvest), five animals received a bio-bullet implant.

Upon completion of the finishing period, steers were humanely harvested using conventional commercial procedures at the Excel beef processing facility in Dodge City, KS. Average carcass weight was 836 lb and most (80.0%) of the cattle graded Choice or Prime, indicating that the cattle were fed to an accepted industry end point. After grading, carcasses were fabricated, and Oklahoma State University personnel collected the treated (i.e., left) bottom round flats from each of the carcasses. Additionally, the opposite paired bottom round flat from each of the carcasses from steers that received a bio-bullet either 7, 14 or 21 d prior to harvest.

Upon arrival to the Food and Agricultural Products Center located on the Oklahoma State University campus, round samples were stored for 14 d at refrigeration temperatures under

vacuum with the absence of light. At the conclusion of the storage period, each sample was trimmed free of external fat, evaluated, which involved dissection into .5 in strips followed by observation and palpation for the presence of injection-site lesions. When a lesion was identified, it was verbally described and measured. Furthermore, a random sample of lesions was collected and placed in 10% formaldehyde and subsequently sent to the Oklahoma State University Veterinary Diagnostic Laboratory for histopathological examination. To ensure objectivity, all histopathological slides were examined without knowledge of the pharmacologic agent introduced or the age of the lesion.

Following the physical examination of the round samples, steaks from treated animals in which lesions were found and their control paired counterparts were collected and Warner-Bratzler shear force values measurements were obtained for each sample as a prediction of tenderness. The steaks were cut on each side of the lesion in the treated bottom round flats and from the corresponding locations in the paired counterparts. Steaks were broiled in an impingement oven at 350^{o}F to an internal temperature of 140 ^{o}F (i.e., medium degree of doneness). Temperatures were monitored with a digital thermometer. Individual steak weights were obtained prior to and after cooking for the calculation of cooking loss percentages. Upon cooling to 70 ^{o}F, four to five cores (.50 in. diameter) were removed parallel to the muscle fiber orientation and sheared. The cores were numbered from left to right with the point of origin being the anterior side of the steaks. The third core taken was always in the center of the steak. The peak load (lb) of each core was recorded. Mean peak load of each sample was calculated and analyzed. It should be mentioned that each core was individually identified so that any influence of steak location could be detected and discussed.

Results and Discussion

Lesion incidences associated with administration times of 7, 14, 21, 28 and 35 d prior to harvest are listed in Table 1. It became obvious that this particular pharmaceutical needed at least 14 d to be totally absorbed in the muscle of the treated animals. Four of the five animals treated only 7 d prior to harvest exhibited slight tissue damage and the presence of the implant.

The incidence of injection-site lesions as affected by pre-harvest administration time revealed that that no visible tissue damage occurred when the bio-bullet system was utilized 21 d prior to harvest.

Table 1: Incidence of injection-site lesions associated with administration of ceftiofur sodium bio-bullet into beef round muscle at various pre-harvest times

Pre-harvest administration time, d[a]	Number of animals Injected	Incidence of lesions/visible implant
7	5	80%[d]
14	5	20%[c]
21	5	0%[b]
28	5	0%[b]
35	5	0%[b]

[a]Pre-harvest administration time: time in which the bio-bullet implant was administered prior to harvest

[b,c,d]Within a column, means lacking a common superscript letter differ (P<.05)

As mentioned in the procedures section, each core sample from each steak was individually identified so that any area containing the muscle damage (i.e., if any lesions were found) could be studied as for what impact the damage had on cooked steak tenderness. The information in Table 2 highlights these findings.

No differences (P<.05) were observed in the tenderness measures between the treated and control round samples. This was the case for all of the pre-harvest administration times that were tested (i.e., d 7, 14 and 21).

No differences in shear force values were observed. In turn, the location of the core did not influence beef tenderness as measured with a Warner-Bratzler shear machine. In other words, cores from the number 1 location had similar tenderness measures regardless of treatment with the bio-bullet implant system when compared to the number 1 cores from the control steaks.

Steaks from the 7 d treated rounds, which contained some detectable tissue damage, showed no differences in tenderness when compared to their non-treated control counterparts.

Following cooking, no visible implant or tissue damage could be observed in the treated steaks.

Table 2: Impact of the ceftiofur sodium bio-bullet on cooked beef shear force values (lbs.) stratified by pre-harvest implant administration time and core location

Item[a]	Overall	Core Location				
		1	2	3	4	5
	Mean					
Treated, d 7	11.71	10.89	11.58	12.12	10.89	11.58
Control, d 7	12.02	10.65	11.28	11.89	11.25	12.37
Treated, d 14	11.48	10.67	11.56	11.02	10.46	10.89
Control, d 14	11.01	10.34	11.59	10.93	11.23	11.75
Treated, d 21	10.87	9.87	10.23	9.92	10.89	11.18
Control, d 21	10.49	10.57	10.03	10.03	10.45	11.09

[a]Item: refers to the animal as being treated with a bio-bullet implant and how many d it was treated prior to harvest

Implications

From an animal-handling standpoint, the Ballistic Technologies bio-bullet technology appears to be superior to other pharmaceutical delivery systems. In fact it can be utilized in all sectors of the beef industry. Since tenderness is not jeopardized by the bio-bullet system, the beef-feeding sector could follow standard pharmaceutical withdrawal protocols allowing any tissue repair to occur prior to harvest.

It appears that sufficient research, testing and thought has been incorporated into the Ballistic Technologies, Inc. bio-bullet system. Not using this system 14 d prior to harvest allows this technology to provide humane treatment and handling of animals during pharmaceutical delivery, while not creating unwanted defects in muscle tissue or cooked steaks and roasts.

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