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Abstract

Ractopamine hydrochloride (Elanco, Greenfield, IN) and Zilmax (zilpaterol hydrochloride; Intervet/ Schering-Plough, Millsboro, DE) are β-adrenergic agonists approved in the United States and several other countries to increase growth rate, improve efficiency of feed utilization, and increase carcass meat yield. Zilmax has been shown to improve feed efficiency by 26% and increase hot carcass weight, longissimus muscle area, and meat yield. However, a few studies have shown that Zilmax significantly increased Warner-Bratzler shear force values (decreased tenderness). The objectives of our research were to determine the effects of supplementing feedlot diets of steers and heifers with Zilmax for 0, 20, 30, or 40 days before harvest and the subsequent effects of 7, 14, and 21 days of aging on tenderness of steer and heifer Longissimus lumborum (from strip loins) and heifer Triceps brachii (from chuck clods) and Gluteus medius (from top sirloin butts) muscles.

Keywords

Cattlemen's Day, 2010; Kansas Agricultural Experiment Station contribution; no. 10-170-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1029; Beef Cattle Research, 2010 is known as Cattlemen's Day, 2010; Beef; Steers; Heifers; Zilmax; Warner-Bratzler shear force

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Supplementing Feedlot Steers and Heifers with Zilmax Increases Proportions of Strip Loin, Chuck Clod, and Top Sirloin Steaks Exceeding Warner-Bratzler Shear Force Thresholds, Whereas Aging Moderates This Effect

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Introduction

Ractopamine hydrochloride (Elanco, Greenfield, IN) and Zilmax (zilpaterol hydrochloride; Intervet/Schering-Plough, Millsboro, DE) are β-adrenergic agonists approved in the United States and several other countries to increase growth rate, improve efficiency of feed utilization, and increase carcass meat yield. Zilmax has been shown to improve feed efficiency by 26% and increase hot carcass weight, longissimus muscle area, and meat yield. However, a few studies have shown that Zilmax significantly increased Warner-Bratzler shear force values (decreased tenderness).

The objectives of our research were to determine the effects of supplementing feedlot diets of steers and heifers with Zilmax for 0, 20, 30, or 40 days before harvest and the subsequent effects of 7, 14, and 21 days of aging on tenderness of steer and heifer *Longissimus lumborum* (from strip loins) and heifer *Triceps brachii* (from chuck clods) and *Gluteus medius* (from top sirloin butts) muscles.

Experimental Procedures

Out of 2,300 steers and 2,400 heifers from a larger study, 117 steers and 132 heifers were selected for the current study. These cattle were British and British × Continental crossbreds. In the large study, steers and heifers were blocked by initial weight into six blocks of four pens, and each pen contained one treatment. Zilmax was fed daily at a concentration of 7.56 g/ton on a 100% dry matter basis. One pen in each block received no Zilmax (control), and the other pens received Zilmax for 20, 30, or 40 days followed by a 3-day withdrawal before slaughter. Steers were slaughtered in two groups, and all heifers were slaughtered at a later date in two groups at the same plant. The first half of each gender was slaughtered at a weight acceptable to a typical feedyard and by visual appraisal of finish, with the target of approximately 60% Choice and a maximum of 15% yield grade 4 and 5 carcasses. We randomly selected carcasses of steers and heifers

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from the larger study to be A maturity and to approximately equally represent USDA Choice and Select quality grades and yield grades 1+, 2-, 2+, 3-, 3+, and 4.

Steer and heifer strip loins, chuck clods, and top sirloin butts were received at the Kansas State University Meat Laboratory from Tyson Fresh Meats at 7 days postmortem. The muscles were received in four different shipments according to slaughter date. The strip loins were then cut into nine uniform, 1.0-in. thick steaks containing only the *Longissimus* muscle. Three of the steaks were individually vacuum packaged for Warner-Bratzler shear force determinations, and the remaining six were sent to the Texas Tech University Meats Laboratory for consumer sensory analysis. Steaks that were to be used for 14- and 21-day Warner-Bratzler shear force determinations were aged in vacuum at 4°F for an additional 7 or 14 days and then frozen until tenderness evaluation. On the last two shipment days, heifer shoulder clods and top sirloins were obtained, and the *Triceps brachii* and *Gluteus medius* muscles, respectively, were removed and cut into 1.0-in.-thick steaks and aged until 14 and 21 days postmortem as described for the *Longissimus* muscle.

The three types of steaks were in frozen storage for 2 to 4 months, depending on the date of fabrication, thawed, and then only one muscle type was cooked per day. Between 30 and 120 steaks were cooked and sheared each time; the 7-, 14- and 21-day aged treatments each represented approximately one third of the steaks each day. Steaks were cooked on a Next Grilleration George Foreman Digital Grill (conduction cookery) to a medium degree of doneness (158°F). Cooked steaks were chilled overnight, and then six 0.5-in. cores were obtained for Warner-Bratzler shear force measurements.

The experimental design for the effect of Zilmax treatment on Warner-Bratzler shear force was a randomized complete block design with a split-plot. There were six blocks, each containing four pens for both steers and heifers. The blocking factor was initial animal weight, and each pen contained one treatment. The whole-plot treatment factor was Zilmax at feeding levels of 0 (controls), 20, 30, and 40 days. Heifer and steer data were analyzed separately because they were from different sources and harvested at different times. Analyses were done using the MIXED procedure in SAS (SAS Institute Inc., Cary, NC). The main effects of treatment and aging and their interactions were tested using a significance level of 0.05. The design for testing a threshold level of Warner-Bratzler shear force was the same as for testing the effect of Zilmax treatment on Warner-Bratzler shear force; analyses were done using the GENMOD procedure of SAS with binomial distribution and the logit-link function.

Results and Discussion

There was no ($P>0.05$) treatment-by-aging interaction for steer *Longissimus* muscle Warner-Bratzler shear force; therefore, Zilmax treatment main effects are shown in Figure 1. The 20-day Zilmax treatment increased ($P<0.05$) Warner-Bratzler shear force of steaks 1.1 lb compared with controls. Steaks from 20-day Zilmax steers had 1.76 lb less ($P<0.01$) Warner-Bratzler shear force than steaks from 40-day Zilmax steers. Although steer and heifer data were analyzed separately, *Longissimus* muscles from heifers averaged about 1.1 lb higher Warner-Bratzler shear force than those from steers. There were no treatment-by-aging interactions ($P>0.05$) for Warner-Bratzler shear force of heifer *Longissimus* or *Triceps brachii* muscles. The Zilmax treatment and aging

means for these two heifer muscles are also shown in Figure 1. *Longissimus* steaks from control heifers had >2.4 lb less (P<0.05) Warner-Bratzler shear force than steaks from 30- and 40-day Zilmax heifers. *Triceps brachii* steaks from 20-, 30-, and 40-day Zilmax heifers had higher (P<0.05) Warner-Bratzler shear force than steaks from control heifers, but there were no (P<0.05) differences among the 20-, 30-, and 40-day Zilmax treatments.

There was a treatment-by-aging interaction (P<0.05) for Warner-Bratzler shear force of heifer *Gluteus medius* muscles (Figure 2). The Warner-Bratzler shear force of *Gluteus medius* muscles from 20-day Zilmax heifers was not different (P>0.05) from that of controls after 7 days of aging or from the 30- or 40-day Zilmax treatments after 14 and 21 days of aging. After 21 days of aging, Warner-Bratzler shear force of *Gluteus medius* muscles from 40-day Zilmax heifers was higher (P<0.05) than that of controls by 1.1 lb.

The *Gluteus medius* Warner-Bratzler shear force means for the 30- and 40-day Zilmax treatments decreased (P<0.05) from 7 to 14 days of aging, but no treatment decreased (P>0.05) from 14 to 21 days (Figure 2). Means for the 30- and 40-day Zilmax treatments were higher than those for controls and the 20-day Zilmax treatment after 7 days of aging and higher than those for controls at 14 and 21 days of aging.

As the aging time of heifer *Longissimus* muscle increased from 7 to 14 to 21 days, Warner-Bratzler shear force decreased (P<0.01) from 11.5 to 9.5 to 8.6 lb, respectively. The Warner-Bratzler shear force of heifer *Triceps brachii* muscle decreased (P<0.01) to a lesser extent from 9.7 to 9.0 to 8.6 lb as aging increased from 7 to 14 to 21 days, respectively. For heifer *Guteus medius* muscles, the 30-day Zilmax treatment generally had the greatest response to aging, but the 20-day Zilmax treatment had no response (Figure 2).

Published research specifies Warner-Bratzler shear force values that might correspond to unacceptable tenderness as perceived by consumers. The value of 10.1 lb often is used as a threshold value, and we also used this value. The percentages of steaks that exceed the threshold value might be more important than treatment means. Table 1 shows the percentages of steer *Longissimus* steaks that exceeded the threshold of 10.1 lb for the combinations of Zilmax treatment and aging. The percentage of steaks from the 20-day Zilmax treatment aged at least 14 days that exceeded the threshold is very low (10%). As expected, the percentage of steaks from the 40-day Zilmax treatment aged only 14 days that were above the threshold value was relatively high (37%). These percentages were higher (P<0.05) than those for the control and 20-day Zilmax treatment.

Table 1 shows the percentages of heifer *Longissimus* muscle steaks that exceed the threshold of 10.1 lb for the combinations of treatment and aging. These data clearly show that a high percentage (79%) of steaks from all Zilmax treatments aged for 7 days exceeded threshold levels. The percentages of steaks aged 14 days that exceeded the 10.1-lb threshold were higher (P<0.05) for the 30- and 40-day Zilmax treatments than for the control and 20-day Zilmax treatments. After 21 days of aging, the percentages of steaks from the control and 20-day Zilmax treatments that exceeded the 10.1-lb threshold were not different (P>0.05) from those of steaks from the 30- and 40-day Zilmax treatments.

For heifer *Triceps brachii* muscle, 18% of steaks from the 20- and 30-day Zilmax treatments exceeded the 10.1-lb threshold after 21 days of aging. For the heifer *Gluteus medius* muscle, aging steaks for 14 or 21 days still resulted in 45% of steaks from the 20-day Zilmax treatment exceeding the 10.1-lb threshold (Table 1). The difference in percentages between steaks from the control and 20-day Zilmax treatments was significant ($P<0.05$). Interestingly, there was little difference in the percentage of steaks exceeding the 10.1-lb threshold between the 20-, 30-, and 40-day Zilmax treatments after 21 days of aging (39% to 48%). Given that 20% of G*luteus medius* steaks from control cattle exceeded the 10.1-lb threshold after 21 days of aging, tenderness of heifer *Gluteus medius* muscle is problematic, especially for Zilmax-treated cattle.

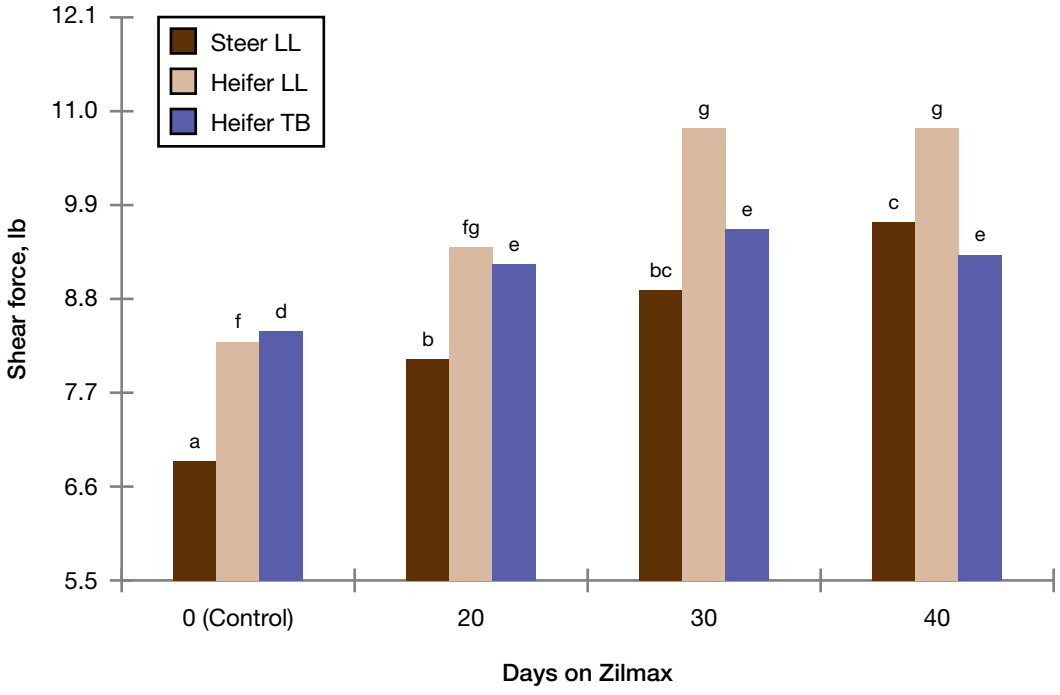
There were no differences ($P>0.05$) in the percentage of intramuscular fat for any muscle among the control or Zilmax treatments. However, the percentage of intramuscular fat of steer *Longissimus* muscle tended ($P=0.06$) to decrease as Zilmax treatment increased from the control to 40 days (data not shown). Percentage of intramuscular fat had little effect on tenderness. Furthermore, none of the correlations within Zilmax treatments among Warner-Bratzler shear force values of different muscles from heifers at different aging times were significant ($P>0.10$; data not presented). The low, nonsignificant correlations among the muscle-by-aging treatment combinations suggest that increases or decreases in Warner-Bratzler shear force for any of the three muscles might not relate to increases or decreases in Warner-Bratzler shear force of other muscles from the same animal aged for the same amount of time.

Implications

Beneficial effects of supplementing feedlot diets with Zilmax to capitalize on growth and carcass composition must be balanced with negative effects on tenderness. When Zilmax is fed to benefit growth and carcass composition, only 20 days of supplementation coupled with 21 days of aging is recommended.

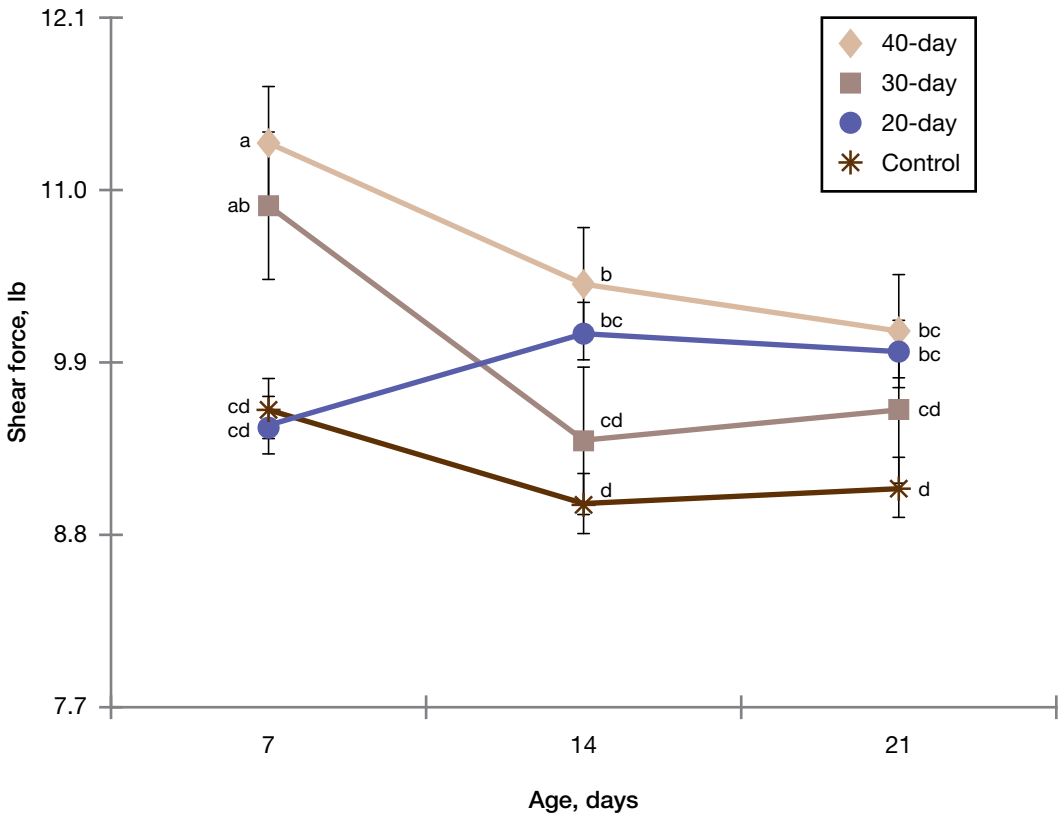
Table 1. Percentages of steer *Longissimus* and heifer *Longissimus*, *Gluteus medius* and *Triceps brachii* steaks aged for 7, 14, or 21 days that exceeded the 10.1-lb Warner-Bratzler shear force threshold

Muscle	Zilmax treatment	7-day aging	14-day aging	21-day aging
Steer *Longissimus*	control	6.9	6.9	0.0
	20-day	10.2	10.3	6.7
	30-day	35.1	20.9	12.8
	40-day	46.6	36.1	25.9
Heifer *Longissimus*	Control	40.4	22.8	15.2
	20-day	66.5	20.9	17.4
	30-day	77.9	54.3	33.1
	40-day	79.1	56.4	28.3
Heifer *Triceps brachii*	Control	11.8	2.9	0.0
	20-day	30.1	17.5	17.5
	30-day	55.9	23.7	17.6
	40-day	41.9	30.0	22.2
Heifer *Gluteus medius*	Control	43.4	23.4	20.0
	20-day	41.1	44.5	44.5
	30-day	63.0	26.4	38.5
	40-day	55.6	55.6	47.5



Within muscle, means without a common letter differ (P<0.05).

Figure 1. Effect of Zilmax treatment on Warner-Bratzler shear force of steer and heifer *longissimus lumborum* (LL) and heifer *triceps brachii* (TB) muscles.



Means without a common letter differ (P<0.05).

Figure 2. Interaction between aging and Zilmax treatment on Warner-Bratzler shear force of heifer *Gluteus medius* muscle.