Perspectives on the application of zilpaterol hydrochloride in the United States beef industry

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ABSTRACT: Zilpaterol hydrochloride (ZH) is a β-adrenergic agonist approved to be fed at a rate of 8.3 mg/kg (100% DM basis) during the final 20 to 40 d of the finishing period in beef cattle followed by a minimum 3-d withdrawal period antemortem. The Federal Drug Administration (FDA) approved label claims of increased rate of BW gain, improved feed efficiency, and increased carcass leanness. Before the release of ZH for commercial use in 2007, approximately 10 independent research trials at various universities and commercial feedlots were initiated. Articles in recent issues of the *Journal of Animal Science* are a result of the large comprehensive body of research designed to increase the understanding of the effect of ZH on beef cattle growth, carcass traits, and beef quality. The feeding of ZH for 20 to 40 d with a 3-d withdrawal resulted in significantly increased ADG. The increases equate to an average of 9 kg heavier BW in ZH-fed steers. Hot carcass weight has been shown to increase to a larger degree compared with BW, with an average improvement of 15 kg. Dressing percent is increased by 1.5 to 2.0% with the feeding of ZH. Increases in carcass leanness were reported for cattle fed ZH mainly through a reduction in yield grades. The LM area was increased, along with yield of subprimal cuts from the round, flank, and loin. Warner-Bratzler shear force studies have shown LM steaks from ZH-treated cattle to have increased shear force values of 1.1 to 1.7 kg for 7-d-aged steaks, 0.4 to 1.3 kg for 14-d-aged steaks, and 0.27 to 1.4 kg for 21-d-aged steaks compared with controls. Recent research has suggested that the aging response is normal in ZH steaks. Consumers were able to identify tenderness differences in 14-d-aged Choice steaks from cattle fed ZH for 20 d compared with 14-d-aged steaks from control cattle; this difference was mitigated with 21 d of postmortem aging. Zilpaterol hydrochloride has been shown to increase cattle growth and efficiency as well as lean tissue deposition in the carcass, with some impact on carcass traits such as Warner-Bratzler shear force.

Key words: β-adrenergic agonist, beef cattle, zilpaterol hydrochloride

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INTRODUCTION

Zilpaterol hydrochloride (**ZH**) is an approved, orally active β-adrenergic agonist (Zilmax, Intervet Schering Plough Animal Health, DeSoto, KS). Zilpaterol hydrochloride was approved by the US Food and Drug Administration (**FDA**) in August 2006 (FDA, New Animal Drug Application 141-258). Zilpaterol hydrochloride can be fed to feedlot cattle at a rate of 8.3 mg/kg during the final 20 to 40 d of the finishing period followed by a minimum 3-d withdrawal period. The FDA-approved label claims increased rate of BW gain, improved feed efficiency, and increased carcass leanness in cattle fed in confinement for slaughter during the last 20 to 40 d on feed.

Before approval of ZH in the United States, the product was approved in South Africa (1997) and Mexico (1999) for use in feedlot cattle. More recently, ZH was approved for use in beef cattle in Canada (2009). These multiple approvals in various countries indicate the international acceptance of this product for improved beef cattle growth and efficiency. Although ZH was approved by the FDA in 2006, the manufacturer did not begin marketing this product for commercial use in the United States until May 2007. During this interim period, approximately 10 independent research trails at various universities and commercial research feedlots were initiated to increase our understanding of the most appropriate feeding strategies of this product in the beef industry. Upon completion of these 10 feeding trials, carcasses were collected and shipped to several

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different university meat labs across the United States to begin a comprehensive evaluation of the impact of ZH on carcass traits, fabrication yield, and beef quality attributes. These articles, contained in recent issues of the *Journal of Animal Science*, are a result of this large, comprehensive body of research designed to increase our understanding of the effects of ZH on beef cattle growth, carcass traits, and beef quality. Results of these research findings have been used to establish best management practices for the use of ZH in the US cattle feeding industry.

FEEDLOT PERFORMANCE

Feeding ZH to steers the last 20 to 40 d of the feeding period with a 3-d withdrawal has resulted in significant increased ADG during the ZH-feeding period and the entire trial period (Vasconcelos et al., 2008; Elam et al., 2009). These changes in ADG brought about an average of 9 kg heavier final BW in ZH-supplemented steers compared with control steers. Feed intake has been reported to remain unchanged (Elam et al., 2009) or decrease (Vasconcelos et al., 2008) during the ZH feeding period. Due to these effects on DMI, G:F is increased due to ZH-feeding the last 20 to 40 d in beef steers. Vasconcelos et al. (2008) reported that feeding ZH more than 20 d gave no further advantages to ADG. In addition, economic signals exist so that a 20-d ZH feeding period with a 3-d withdrawal has become the normal feeding regimen for US beef feedlots using ZH.

Interestingly, even though BW is increased an average of 9 kg in beef steers fed ZH compared with control steers, HCW was increased approximately 15 kg (Vasconcelos et al., 2008; Elam et al., 2009). The increase in HCW relative to BW resulted in changes in dressing percent. Dressing percent (**DP**) increased approximately 1.5 to 2.0 percentage units due to ZH administration. However, in addition to these advantages in DP, it is hypothesized that ZH feeding is regulating metabolism and mobilization of noncarcass components and shifting these nutrients to carcass components to realize this change in HCW gain as compared with BW change.

CARCASS CUTABILITY AND MEAT QUALITY ATTRIBUTES

Rathmann et al. (2009) fed steers a finishing ration that included ZH for 0, 20, 30, or 40 d with a 3-d withdrawal and evaluated carcass composition and cutability. Rathmann et al. (2009) described that ZH had an effect on carcass cutout because 22 of the 33 subprimal yields evaluated displayed a positive difference between the control and ZH treatment groups with the most consistent ZH effect seen in the round (all subprimals were increased 0.25 to 5.84%). Carcasses from cattle fed ZH had more protein and moisture when compared with those from the control group (0 ZH).

Kellermeier et al. (2009) fed 2,279 crossbred steers (with and without a terminal implant) ZH for 30 d to determine the effect of ZH on carcass traits and retail cutout. When compared with the control, feeding ZH for 30 d (with a terminal implant) significantly increased HCW by 15 kg and LM area by 14% and decreased the carcass yield grade, marbling score, and USDA quality grade (control with implant 19.35% USDA Choice; ZH with implant 16.67% USDA Choice). Feeding ZH increased the yield of the chuck mock tender, ribeye roll, knuckle, inside round, outside round, eye of round, strip loin, top sirloin butt, and tenderloin.

Calf-feeding Holstein steers is a successful method of delivering good quality beef from dairy-type steers. Studies conducted to evaluate the effects of feeding ZH for 20 to 40 d on carcass characteristics of calf-fed Holstein cattle have demonstrated increased DP, HCW, and LM area, a decrease in marbling score, and no effect on lean and skeletal maturity score, fat thickness, KPH, subprimal purge, and thaw loss (Beckett et al., 2009; Holmer et al., 2009). Beckett et al. (2009) conducted 2 experiments involving approximately 2,400 cattle (Holstein steers) fed ZH for 0, 20, 30, or 40 d. In Exp. 1, feeding ZH for 20 d increased HCW by 11.6 kg and increased the DP by 1.5 percentage units. In addition, the authors noted that this increase in HCW shifted the distribution of HCW and reduced the percentage of lightweight carcasses (potentially less desirable, out of specification carcasses). In Exp. 2, HCW and DP were increased by all durations of feeding ZH and muscling was increased when ZH was fed for as little as 20 d. In Exp. 1 and 2, feeding ZH significantly reduced marbling score and increased yield grade 1 and 2 carcasses. Additionally, yield grade 3 and 4 carcasses were reduced in Exp. 1.

Holmer et al. (2009) reported the results of 3 separate experiments to determine the effect of feeding ZH to calf-fed Holstein cattle for 0, 20, 30, or 40 d on subprimal purge, fat content, and cook loss. Subprimals (strip loin, top butt, and shoulder clod) from beef fed ZH, held for 7 d, had less than 0.60% purge, and there were no differences between ZH treatments (0, 20, 30, or 40 d). Feeding ZH for 20 or 30 d did not affect the percentage of moisture in the 3 subprimals. Only slight fat differences were identified with a difference between 0- and 30-d ZH for all 3 subprimals. No differences were identified for thaw loss and cooking loss for top butt and shoulder clod from steers fed ZH for 0, 20, or 30 d.

Boler et al. (2009) fabricated carcasses from calf-fed Holstein steers fed ZH for 0, 20, 30, or 40 d and measured the cutability and subprimal yield. Feeding ZH for as little as 20 d increased chilled side weight by 6.22 kg and red meat yield by 6.40 kg when compared with carcasses from cattle not fed ZH. The knuckle, top round, bottom round, eye of round, and heel meat were all heavier from steers fed ZH for 20 d (12.03%) compared with the control (11.47%). Feeding ZH tended to

increase the weight of cuts from the loin/flank but to a lesser degree than the round. The increase in subprimal weight led to a greater percentage of saleable yield.

Shook et al. (2009) evaluated carcass fat-to-lean ratios from beef steers fed ZH for 20 d with a withdrawal of 3, 10, 17, or 24 d before slaughter. Steers fed ZH for 20 d resulted in heavier side weights (control 180.97 kg and ZH 184.30 kg) and an increase in the total wholesale carcass lean. The strip loin, tenderloin, top sirloin, tri-tip, inside round, bottom round, and eye of round increased when expressed as a percentage of chilled side weight.

Color has been addressed in recent studies from a carcass quality perspective as well as color stability with various muscles in different packaging systems during storage and retail display. Montgomery et al. (2009) found no difference in dark cutters for steers or heifers when fed ZH 20 or 40 d compared with controls. Skeletal, lean, overall maturity, color, and dark cutter scores were not affected by feeding ZH. Steer studies have demonstrated no difference in lean maturity when fed ZH 0, 20, 30, or 40 d or when the cattle had different days on feed (Vasconcelos et al., 2008; Elam et al., 2009). Hilton et al. (2009) found LM steaks from cattle fed ZH 30 d, vacuum-aged 14 d postmortem, and packaged with polyvinyl chloride (**PVC**) film for retail display maintained a brighter cherry red color throughout the 5-d retail display than did the controls. There were few differences in retail display color for the semimembranosus (**SM**) from beef steers fed 0, 20, 30, or 40 d and packaged with PVC film, in high-oxygen modified atmosphere or in carbon monoxide (Gunderson et al., 2009a). The 40-d SM steaks in high-oxygen modified-atmosphere packaging became more discolored than the other treatments by d 3 of display, whereas SM steaks in PVC had no ZH effect and SM control and 40-d steaks in carbon monoxide modified-atmosphere packaging became more discolored than the other treatments by d 8 of display. In SM from calf-fed Holstein steers there was no difference in ZH and control for initial color for any packaging system (Gunderson et al., 2009b). Instrumental color scores showed few positive or negative differences, and most differences were not detected in the visual scores with panelists. In both SM studies and the LM study, the 20-d or 30-d ZH or both performed as well or better than the control (Gunderson et al., 2009a,b; Hilton et al., 2009).

TENDERNESS AND CONSUMER ACCEPTABILITY

Warner-Bratzler shear force (**WBSF**) studies have shown that there is between a 1.1- to 1.7-kg increase in 7-d-postmortem-aged LM steaks, 0.4 to 1.3 kg increase in 14-d-postmortem-aged steaks, and 0.27- to 1.4-kg increase in 21-d-postmortem-aged steaks when comparing controls with 20-, 30-, or 40-d-fed ZH steaks (Hilton et al., 2009; Kellermeier et al., 2009). There is a 0.6- to 0.72-kg difference in control vs. 20-d ZH across aging time periods, 0.75- to 1.11-kg difference in controls vs. 30-d ZH, and 0.72 to 1.17 kg in control vs. 40-d ZH feeding (Brooks et al., 2009; Leheska et al., 2009). Similar trends are observed with the triceps brachii and gluteus medius (Brooks et al., 2009). Recent studies have shown that steaks from ZH-fed animals have a normal aging response (Brooks et al., 2009; Hilton et al., 2009; Kellermeier et al., 2009; Rathmann et al., 2009), and some have suggested that the aging response is greater in the ZH steaks than controls (Holmer et al., 2009). So, as normal US industry aging time periods are met, there is less of a difference between controls and ZH LM steaks. Feeding ZH did significantly increase WBSF. However, feeding ZH the recommended 20 d reduced the chance of getting a tough steak (compared with longer ZH feeding) and still maximizing the yield benefit (Brooks et al., 2009).

Three consumer studies have been conducted to look at the acceptance of LM steaks from cattle fed ZH (n = 2 beef steaks; n = 1 calf-fed Holstein steak). In the first study (Hilton et al., 2009), consumers (n = 564) found no difference in juiciness, flavor, overall quality, tenderness acceptability (consumers asked yes or no for acceptability of tenderness), or overall acceptability from 30-d ZH LM steaks aged 14 d postmortem despite picking up a difference in tenderness. In this study, trained panelists identified some differences that consumers did not. Consumers (n = 3007) in a 4-city study were able to detect a difference in tenderness between control and 20-d ZH Choice steaks after 14 d postmortem aging, but this was mitigated by 21-d postmortem aging, and other palatability traits were not different (Mehaffey et al., 2009). Consumers did not identify palatability differences between control and 20-d ZH steaks in 14- d- or 21-d-aged USDA Select steaks. Similar trends and acceptability were seen in the consumer data for steaks from calf-fed Holsteins (Mehaffey et al., 2009). Current industry averages of postfabrication aging are 22 d for retail and 30 d for foodservice (Voges et al., 2007), which these studies demonstrate mitigate any differences consumers find in tenderness by those time periods. Consumer palatability results indicate that overall acceptability of steaks from carcasses of ZH-fed cattle are similar to steaks from control cattle even in light of these changes in WBSF.

CONCLUSIONS

Feeding ZH the last 20 d to finishing cattle has effects on growth, efficiency, and lean tissue deposition in the carcass. These changes in lean tissue resulted in desirable fabrication yields of these carcasses. With these changes in muscle hypertrophy in carcasses from cattle fed ZH the last 20 d of the feeding period, some beef quality characteristics would be expected to be affected. Indeed, WBSF values are greater in steaks from cattle fed ZH during the finishing period compared with steaks from control cattle. These observed changes in WBSF were most likely a result of the effect ZH has

on muscle hypertrophy in vivo. Consumer acceptability trials indicate that these changes in tenderness have minimal effects on consumer acceptance. In addition, other beef quality attributes like lean color are not affected by feeding ZH. Taken together, these data indicate that ZH can be an important management tool in the US beef industry. Continued research will aid in optimizing the use of this product to enhance growth efficiency and ensuring adequate beef quality.

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