Predicting red meat yields in carcasses from beef-type and calf-fed Holstein steers using the United States Department of Agriculture calculated yield grade


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ABSTRACT: Analyses were conducted to evaluate the ability of the USDA yield grade equation to detect differences in subprimal yield of beef-type steers and calf-fed Holstein steers that had been fed zilpaterol hydrochloride (ZH; Intervet Inc., Millsboro, DE) as well as those that had not been fed ZH. Beef-type steer (n = 801) and calf-fed Holstein steer (n = 235) carcasses were fabricated into subprimal cuts and trim. Simple correlations between calculated yield grades and total red meat yields ranged from −0.56 to −0.62 for beef-type steers. Reliable correlations from calf-fed Holstein steers were unobtainable; the probability of a type I error met or exceeded 0.39. Linear models were developed for the beef-type steers to predict total red meat yield based on calculated USDA yield grade within each ZH duration. At an average calculated USDA yield grade of 2.9, beef-type steer carcasses that had not been fed ZH had an estimated 69.4% red meat yield, whereas those fed ZH had an estimated 70.7% red meat yield. These results indicate that feeding ZH increased red meat yield by 1.3% at a constant calculated yield grade. However, these data also suggest that the calculated USDA yield grade score is a poor and variable estimator (adjusted R2 of 0.31 to 0.38) of total red meat yield of beef-type steer carcasses, regardless of ZH feeding. Moreover, no relationship existed (adjusted R2 of 0.00 to 0.01) for calf-fed Holstein steer carcasses, suggesting the USDA yield grade is not a valid estimate of calf-fed Holstein red meat yield.

Key words: beef, red meat yield, yield grade, zilpaterol hydrochloride

INTRODUCTION

Zilpaterol hydrochloride (ZH) has recently been approved in the United States for commercial use in a feedlot setting. Previously reported research has shown that feeding the β2-adrenergic agonist ZH to cattle for the last 20 to 40 d before slaughter improves carcass red meat yield (Hilton et al., 2010). Published data have illustrated that β-adrenergic agonists increases muscle mass via hypertrophy. Lambs fed cimaterol, clenbuterol, or L644,969 had increased muscle area, decreased trimmable subcutaneous fat, improved USDA yield grades (YG), and increased lean yield (Baker et al., 1984; Beermann et al., 1986; Hamby et al., 1986; Kim et al., 1987; Shackelford et al., 1992). In addition, administration of clenbuterol in cattle resulted in less 12th-rib fat, more 12th-rib LM area, and improved USDA YG (Ricks et al., 1984). Current beef marketing methods use the USDA stamped YG as the method to estimate red meat yield of the carcass. Additionally, red meat yield estimation using video image analysis has been approved as a method to augment USDA grader
estimated factors. Because YG is one variable in calculating carcass value, it is important to verify that this methodology accurately predicts red meat yield in cattle fed ZH. The objective of this research was to compare the effectiveness of the USDA calculated YG equation for predicting red meat yield from beef-type and calf-fed Holstein steer carcasses of cattle that had been fed ZH for 0, 20, 30, or 40 d before slaughter.

**MATERIALS AND METHODS**

Institutional Animal Care and Use Committee approval was not obtained for this study because the samples were obtained from federally inspected slaughter facilities. Institutional Animal Care and Use Committee approval was obtained for the live animal portions of these experiments.

**Carcass Selection, Grading, and Fabrication**

Beef carcasses (n = 801 beef-type steers; n = 235 calf-fed Holstein steers) from cattle fed ZH (Intervet Inc., Millsboro, DE) for 0, 20, 30, or 40 d were selected from the grading line of commercial processors. Carcasses were evaluated for USDA YG (12th-rib fat thickness, HCW, percentage KPH, LM area) traits and quality grade (marbling score, skeletal maturity, lean maturity) traits (USDA, 1997) as described by Elam et al. (2009) and Beckett et al. (2009). Carcasses were selected to represent the mean HCW ± 1 SD within each ZH treatment. A total of 210 carcasses were fabricated in the facility in which they were slaughtered; the remaining 826 carcasses were transported from a commercial processor via refrigerated trailer for fabrication at either Oklahoma State University, Texas Tech University, or the University of Illinois as described by Hilton et al. (2010) and Boler et al. (2009).

**Table 1.** Mean USDA calculated1 yield grade (YG) and total red meat yield2 of beef-type steer carcasses and calf-fed Holstein steer carcasses selected for fabrication within zilpaterol hydrochloride treatment3

<table>
<thead>
<tr>
<th>Item</th>
<th>Beef-type steers</th>
<th>Calf-fed Holstein steers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 d</td>
<td>20, 30, or 40 d</td>
</tr>
<tr>
<td>≤1.99 YG</td>
<td>n 31 111 4 39</td>
<td>n 39 107 15 43</td>
</tr>
<tr>
<td></td>
<td>Mean USDA calculated YG 1.60 1.50 1.83 1.72</td>
<td>Mean USDA calculated YG 2.78 2.76 2.74 2.79</td>
</tr>
<tr>
<td></td>
<td>Mean total red meat yield, % 71.64 73.83 67.72 69.08</td>
<td>Mean total red meat yield, % 70.90 70.90 68.13 68.99</td>
</tr>
<tr>
<td>2.00 to 2.99 YG</td>
<td>n 60 119 24 43</td>
<td>n 50 98 12 19</td>
</tr>
<tr>
<td></td>
<td>Mean USDA calculated YG 2.78 2.76 2.74 2.79</td>
<td>Mean USDA calculated YG 3.74 3.69 3.85 3.79</td>
</tr>
<tr>
<td></td>
<td>Mean total red meat yield, % 69.85 70.90 68.13 68.99</td>
<td>Mean total red meat yield, % 70.90 70.90 68.13 68.99</td>
</tr>
<tr>
<td>3.00 to 3.99 YG</td>
<td>n 36 38 — —</td>
<td>n 36 38 — —</td>
</tr>
<tr>
<td></td>
<td>Mean USDA calculated YG 4.35 4.29 — —</td>
<td>Mean USDA calculated YG 4.35 4.29 — —</td>
</tr>
<tr>
<td></td>
<td>Mean total red meat yield, % 66.85 68.56 — —</td>
<td>Mean total red meat yield, % 66.85 68.56 — —</td>
</tr>
</tbody>
</table>

1USDA YG = 2.5 + (2.5 × 12th-rib subcutaneous fat thickness, in.) + (0.0038 × HCW, lb) + (0.2 × percentage KPH) − (0.32 × LM area, in.2).
3Cattle were fed zilpaterol hydrochloride (Intervet Inc., Millsboro, DE) for the last 0, 20, 30, or 40 d before slaughter.

**Experimental Design and Statistical Analysis**

The MIXED procedure (SAS Inst. Inc., Cary, NC) was used to quantify differences between each ZH treatment, with calculated YG as a covariate. No difference in red meat yield was detected among the ZH

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treatments ($P = 0.85$); therefore, all ZH treatments were combined into 1 effect. Pearson correlation coefficients were calculated with the CORR procedure. Linear regression models were developed for both beef-type steers and calf-fed Holstein steers using the REG procedure. The dependent variable was percentage of total red meat yield and the independent variable was calculated YG.

### RESULTS AND DISCUSSION

#### Carcass Population

The sample population (Table 1) of beef-type steers was represented by carcasses that were 17.7% YG of 1.99 and less, 40.6% YG of 2.00 to 2.99, 32.5% YG of 3.00 to 3.99, and 9.2% YG of 4.00 and greater. Calf-fed Holstein steers were represented by carcasses that were 18.3% YG of 1.99 and less, 60.9% YG of 2.00 to 2.99, and 20.9% YG of 3.00 to 3.99. In comparison, Garcia et al. (2008) reported 16.5, 36.3, 33.1, and 14.1% in the 2005 National Beef Quality Audit for YG 1 to 4+, respectively.

### Ability of USDA YG to Predict Fabrication Yield

The USDA YG equation was developed as a multiple-linear regression model to predict a percentage of boneless-closely-trimmed-rib-loin-chuck-round, which is also a multiple-linear regression model to estimate the same. The current data (Figure 1 and Table 2) reveal the disparity in red meat yield between carcasses from cattle fed ZH for 0 d and those from cattle fed ZH for 20, 30, or 40 d across YG groupings 1 to 4. In the 2005 National Beef Quality Audit, Garcia et al. (2008) reported a mean calculated YG of 2.9. If extrapolated to the current data, beef-type steer carcasses with a calculated YG of 2.9 from the 0-d or 20-, 30-, or 40-d ZH treatments would yield an estimated 69.4 and 70.7% of chilled carcass weight as total red meat yield, respectively. When comparing the YG 2.9 carcass from a steer fed ZH with the YG 2.9 carcass from a steer not fed ZH, an estimated fabrication yield bias of 1.3% existed. When that bias was extrapolated to a 400-kg carcass, the ZH carcass had 5.2 kg more total red meat than an equal weight, non-ZH counterpart. Furthermore, if purchased on a value-based grid, the beef processor would pay the same YG premium for both carcasses while realizing additional saleable product for the ZH carcass. This discrepancy is further illustrated in Table 1. When comparing non-ZH and ZH carcasses with a calculated YG of 2.00 to 2.49, a difference of 0.04 YG units was noted, whereas a difference in total red meat yield of 1.62% occurred. Likewise, in the 2.50 to 2.99 YG category, a difference of 0.02 YG units occurred, with a corresponding 1.05% difference in red meat yield. The inability of the calculated YG to estimate red meat yield of ZH fed cattle is likely due to the effects this feed additive has on the musculature of the hindquarter. In particular, the loin, sirloin, and round regions of the carcass all increase in yield when expressed as a percentage of carcass weight. The only measurement of muscling used in the USDA YG is the LM area measurement. Because ZH affects the total musculature of the hindquarter and the hindquarters are not measured directly, these effects are not accounted for in the YG calculation.

### Table 2. Linear prediction equations for estimating percentage of total red meat yield from beef-type steers or calf-fed Holstein steers via the calculated USDA yield grade

<table>
<thead>
<tr>
<th>Zipaterol hydrochloride treatment</th>
<th>Cattle type</th>
<th>Adjusted R²</th>
<th>Root mean square error</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 d</td>
<td>Beef-type</td>
<td>0.31</td>
<td>0.022</td>
<td>$= 0.745 - (0.0176 \times \text{CALCYG})$</td>
</tr>
<tr>
<td>20, 30, or 40 d</td>
<td>Beef-type</td>
<td>0.38</td>
<td>0.021</td>
<td>$= 0.767 - (0.0207 \times \text{CALCYG})$</td>
</tr>
<tr>
<td>0 d</td>
<td>Calf-fed Holstein</td>
<td>0.01</td>
<td>0.020</td>
<td>$= 0.661 + (0.0053 \times \text{CALCYG})$</td>
</tr>
<tr>
<td>20, 30, or 40 d</td>
<td>Calf-fed Holstein</td>
<td>0.00</td>
<td>0.019</td>
<td>$= 0.690 - (0.0021 \times \text{CALCYG})$</td>
</tr>
</tbody>
</table>


2USDA yield grade = $2.5 + (2.5 \times 12$th-rib subcutaneous fat thickness, in.) + (0.0038 × HCW, lb) + (0.2 × percentage KPH) − (0.32 × LM area, in.$^2$). CALCYG = calculated yield grade.

3Intervet Inc., Millsboro, DE.

4Probability of a type I error exceeded 0.50 for all calf-fed Holstein equations.

### Table 3. Simple correlations between calculated USDA yield grade and total red meat yield for beef-type steers and calf-fed Holstein steers within zipaterol hydrochloride treatment

<table>
<thead>
<tr>
<th>Zipaterol hydrochloride duration</th>
<th>Beef-type steers</th>
<th>Calf-fed Holstein steers</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 d</td>
<td>−0.56*</td>
<td>0.09**</td>
</tr>
<tr>
<td>20, 30, or 40 d</td>
<td>−0.62*</td>
<td>−0.06***</td>
</tr>
</tbody>
</table>

1Intervet Inc., Millsboro, DE.

* $P < 0.0001$; ** $P = 0.51$; *** $P = 0.39$. 

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In contrast to the yield data from beef-type steers, the red meat yield data for calf-fed Holstein steers, regardless of treatment, had no linear ($P > 0.38$) relationship (simple correlations of $-0.06$ to $0.09$) to the calculated YG (Table 3); furthermore, the probability of a type I error exceeded 0.39 for all treatments. The scatterplot diagram (Figure 2) illustrates the lack of linear relationship between calculated USDA YG and total red meat yield. The inability of the calculated YG to quantify red meat yield of calf-fed Holstein steers is
further described in Table 1. Carcasses in the 0-d ZH by 2.00 to 2.49 YG, 0-d ZH by 3.00 to 3.49 YG, and 0-d ZH by 3.50 to 3.99 YG groupings had red meat yields of 66.4 to 66.9%, yet the average calculated YG of those groupings ranged from 2.34 to 3.85. This disappointing finding is likely the result of what the YG equation measures and what it does not. In particular, the YG equation accounts for trimmable subcutaneous fat, the proportion of one muscle to carcass weight, and the estimated percentage of trimmable internal cavity fat. Percentage of bone, of great importance for accurate estimates of calf-fed Holstein steer fabrication yields, is not accounted for by the YG equation. Within our sample carcasses, beef-type steer carcasses had approximately 13.1% trimmable fat, 16.3% bone, and 70.4% red meat yield (red meat yield:bone ratio of 4.32:1). In contrast, calf-fed Holstein steer carcasses had approximately 10.5% trimmable fat, 21.2% bone, and 68.2% red meat yield (red meat yield:bone ratio of 3.22:1). The use of an estimate of bone quantity may improve the prediction of true red meat yield in calf-fed Holstein carcasses.

Particular attention should be given to the adjusted R$^2$ for predicting total red meat yield when using the USDA calculated YG. These equations, in which the adjusted R$^2$ did not exceed 0.38, indicate the calculated YG is a poor determinant of true fabrication yield. Moreover, the complete lack of a relationship between USDA calculated YG and total red meat yield suggests the YG is an invalid estimate of red meat yield for calf-fed Holstein steers. These data suggest that methods not currently in use should be developed to estimate the red meat yield of carcasses from cattle fed ZH more accurately, regardless of whether they are from beef-type steers or calf-fed Holstein steers.

**LITERATURE CITED**


