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The Effects of Induced Stress and Supplemental Chromium on Meat Quality of Finishing Heifers

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The stress treatments were insufficient to generate dark cutting beef, so the benefits of chromium feeding could not be assessed. Stress reduced tenderness and redness of the lean.

Summary

Organic chromium was fed to heifers to evaluate its effect on reducing the consequence of stress. Cattle in this trial were subjected to induced stress by estrus and social interaction. The induced stress was not sufficient to cause dark cutting beef. Meat from stressed cattle tended to have lower (P = .09) redness (a) values, lower (P = .11) shear force, and higher (P= .09) ultimate pH than non-stressed animals. The effectiveness of chromium in the prevention of dark cutting beef could not be assessed.*

Introduction

Cattle exposed to pre-slaughter stress quickly exhaust their muscle glycogen stores and may produce dark cutting beef. This muscle lacks the essential substrate to produce lactic acid, which is responsible for the normal drop in muscle pH during postmortem metabolism. Meat that possesses a high pH is dark in color, dry in appearance and sticky to the touch.

Chromium is an essential mineral that plays a role in glucose metabolism. This mineral may increase glycogen deposition by increasing the efficiency of insulin. Supplemental chromium may aid in increasing glycogen reserves which may reduce the depletion of glycogen prior to slaughter. This study was conducted to evaluate the effects of stress and the benefits of chromium on meat quality of beef.

Procedure

Fifty crossbred heifers (12 - 13 head per pen) were used in this trial in order to study the effects of induced stress and supplemental organic chromium on the reduction of dark cutting beef. The stress in this trial included estrus and social stress.

Melengesterol acetate (MGA) was supplied in the finishing diets until seven days before slaughter. Removal of MGA was to initiate the onset of estrus. Three days prior to slaughter, cattle that were unfamiliar to the trial heifers were introduced into each pen. This interaction created social stress as the animals sought to re-establish a social order of dominance. Feed was analyzed to ensure that the organic chromium, supplied by a high-chromium yeast product, was provided at 400 ppb per head per day for the 62-day period prior to slaughter. Carcass information for these cattle can be found in Table 1. Meat quality was assessed by measuring pH at 45 minutes post mortem, ultimate pH (8 days post mortem) , L*, a*, and b* (90-minute bloom time), and Warner-Bratzler shear values of the longissimus muscles after 7 days of post mortem aging. The L*, a*, and b* values were used to characterize color. The L* value is the relative lightness or darkness of a color. The a* value is the relative redness of a color and the b* value relates to the level of yellowness of a color.

These treatments were arranged in a 2 x 2 factorial consisting of stress (stressed vs non-stressed) and supplemented dietary chromium (with or without Cr). Interactions were not significant, so only the main effects are presented.

Results

Differences among treatments were subtle. Induced stress failed to produce the dark cutting condition for any treatment within this study. Perhaps not all heifers came into estrus after the removal of MGA. The social interaction may also have been insufficient to deplete glycogen levels below the threshold necessary to induce dark cutting beef. Alternatively, the time from initiation of social stress to slaughter (three days) may have been sufficient for the animals to acclimate to each other and recover to some degree. Although not significant (P=.09), the trend (Table 2) was for stressed cattle to have slightly higher ultimate pH (5.53 vs 5.50), less red color (as expected) and

Table 1. Carcass measures for all treatment groups.

	No Cr, No Stress	No Cr, Stress	Cr, No Stress	Cr, Stress
Hot carcass weight, lb	828.5	824.9	821.6	806.6
Marbling score[a]	19.5	19.6	20.2	20.0
Fat thickness, in	.63	.53	.62	.55
Rib eye area, sq in	14.2	14.0	13.7	13.1
KPH%[b]	2.2	2.1	2.1	2.2
Maturity Score	A70	A66	A70	A62

[a]Marbling Score: 21 = Moderate, 20 = Modest, 19 = Small.
[b]Kidney, pelvic and heart fat percentage.

Table 2. The effect of induced stress on meat quality parameters in longissimus muscles of finishing heifers.

Parameter	Non-stressed	Stressed	P-value
pH 45 minutes post mortem	6.34	6.38	.37
Ultimate pH[a]	5.50	5.53	.09
Warner-Bratzler shear, lb	9.1	9.9	.11
L* (lightness)	38.07	38.27	.70
a* (redness)	32.17	31.54	.09
b* (yellowness)	25.37	25.11	.55

[a]Ultimate pH was determined 8 days post mortem.

Table 3. The effect of supplemental organic chromium on meat quality parameters in longissimus muscles of finishing heifers.

Parameter	Control diet	Supplemental chromium	P-value
pH 45 minutes post mortem	6.36	6.36	.89
Ultimate pH[a]	5.50	5.52	.41
Warner-Bratzler shear, lb	9.48	9.57	.87
L* (lightness)	37.79	38.55	.16
a* (redness)	31.86	31.85	.99
b* (yellowness)	25.27	25.22	.91

[a]Ultimate pH was determined 8 days post mortem.

higher shear values (P=.11, 9.9 vs 9.1 pounds, respectively). It is unlikely that the differences noted for pH are of any practical significance. The significance level may be further evidence that the stress was not completely effective in this study.

Although not significant, the color changes trend in the anticipated direction - stressed animals would be expected to have darker and less red-colored meat. This may suggest that the stress treatment was sufficient to affect meat color, but these color differences were not of practical significance. This is supported further by the fact that the ultimate pH values from the stressed cattle were not different.

Recently, color has been suggested as a means to identify carcasses likely to produce meat that is undesirable in tenderness. Although the differences were relatively small and not significant, the direction of the changes in shear force and color tends to support this strategy.

The absence of dark cutters in this study may explain the absence of any effects due to supplemental dietary chromium for any of the traits studied (Table 3). Given the insufficient stress, it is not possible to assess the beneficial effects of chromium supplementation in this study.

The only parameter that presented any differences by chromium treatment was muscle pH at 45 minutes. Heifers with no chromium supplementation that were stressed had higher (P =.04) pH at 45 minutes than non-supplemented, non-stressed heifers (6.43 vs 6.29 , respectively). These differences were also noted, but at a smaller magnitude and non-significant level, in the stressed and unstressed chromium fed cattle. Ultimate pH was not different among any of the treatments. The ultimate pH value is normally the parameter of greatest interest when dealing with dark cutting beef.

It can be concluded that the stress was insufficient to cause the dark cutting beef condition. This situation makes it difficult to assess the effectiveness of chromium in prevention of dark cutting beef. The data from this trial imply that supplemental organic chromium has subtle effects on meat quality.

The stress treated cattle in this trial did provide information, in the form of tenderness data, that brings up important questions. It has been accepted that stress prior to slaughter may compromise the overall acceptability of meat color. Generally, stress has not been thought to have a detrimental effect on tenderness of beef.

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