ANTE-MORTEM STRESS EFFECTS THE OXIDATIVE PRODUCTS AND COLOUR STABILITY OF STEAKS FOLLOWING RETAIL DISPLAY

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I. INTRODUCTION

Stress is defined as any event invoking a physical, psychological, or emotional response [1]. Stress in the short and long term may contribute to the oxidation of lipids and proteins in vivo, deemed oxidative stress. These damages, in combination with other ante-mortem stress events, can contribute to severe meat quality defects, including decreased hot carcass weight, decline in quality, and less desirable colour. Furthermore, discolouration of beef during retail display costs the industry approximately $3.73 billion annually in discarded product [2]. Therefore, the objective of the study was to evaluate the effect of various stressors on live animal oxidative stress responses and post-mortem meat quality.

II. MATERIALS AND METHODS

Dairy steers (n = 40; 110 ± 11.8 kg BW) were housed in individual pen in an environmentally controlled room at the USDA-ARS Livestock Issues Research Unit. Calves had ad libitum access to water and starter ration. Calves were randomly allotted to 4 treatment groups (n = 10 per treatment): 1) Control, 2) Transport; transported in a livestock trailer for 4 h, 3) Lipopolysaccharide (LPS; i.v administration 0.10 µg/kg BW), 4) Vaccine (*Mannheimia haemolytica* toxoid vaccine; OneShot, Zoetis). On d -1, calves were fitted with indwelling jugular catheters and rectal temperature recording devices. Whole blood was collected at -1, -0.5, 0, 1, 2, 3, and 4 h relative to application of stressors at 0 h, and further processed for plasma for indicators of oxidative stress via colorimetric determination of malondialdehyde (MDA) and total antioxidant capacity (TAC). Calves were humanely euthanized at 6 h, where the entire *Longissimus dorsi* (LD; left side of carcass) was collected, vacuum packaged, and aged 7 d post-mortem. LD from each calf was fabricated into 2.54 cm steaks and allotted to a retail display period of 0, 3, 6, or 9 d in overwrap trays. Steaks aged 9 d were evaluated for instrumental colour and by trained colour panelists every 12 h. Following the allotted aging periods, all steaks were analyzed for MDA concentrations. Data were analyzed as repeated measures using the Proc GLIMMIX procedure in SAS, with individual animal as the experimental unit.

III. RESULTS AND DISCUSSION

An interaction occurred for MDA and TAC ($P < 0.001$). By 1 h, all calves increased in MDA ($P < 0.05$) but increased at 2 h for LPS calves ($P < 0.05$). MDA for vaccine calves increased at 3 h post challenge ($P < 0.05$). All calves had MDA concentrations below baseline by 4 h, except for LPS calves ($P < 0.05$). For all calves, TAC decreased ($P < 0.05$) from -1 to -0.5 h of the challenge. Transport calves had the greatest TAC for the duration of the challenge and peaked at 3 h ($P < 0.05$). TAC for vaccine and LPS calves peaked at 1 h but decreased at 3 h ($P < 0.05$). An interaction occurred for redness and discolouration evaluators ($P \leq 0.011$). Steaks from calves treated with LPS were the palest red ($P < 0.05$) at 0 h of display. While all steaks lightened in redness during the display period ($P < 0.05$), samples from LPS calves were the darkest red by 204 h ($P < 0.05$). Only

samples from LPS calves showed discolouration at 0 h of display ($P < 0.05$), while samples from the other treatments did not. By 24 h of retail display, samples from control, LPS, and vaccine calves had begun to discolour, while samples from transport calves did not discolour until 48 h of display ($P < 0.05$). Discolouration increased ($P < 0.05$) for all samples throughout the display period. At 204 h of display, samples from LPS and vaccine calves had the least discolouration, while samples from control and transport calves had the greatest amount of discolouration ($P < 0.05$). Treatment type affected instrumental metmyoglobin (MMb) percent ($P < 0.001$). Samples from LPS and transport calves showed the greatest percentage of MMb formation ($P < 0.05$). Samples from control and vaccine calves showed the least percentage of MMb formation. An interaction ($P = 0.032$) occurred for steak MDA concentrations. Samples from transport and vaccine calves had the greatest concentration of MDA at 0 d of display ($P < 0.05$). Concentrations of MDA increased in all samples ($P < 0.05$) throughout display, and by d 6, samples from transport calves showed the greatest concentration ($P < 0.05$).

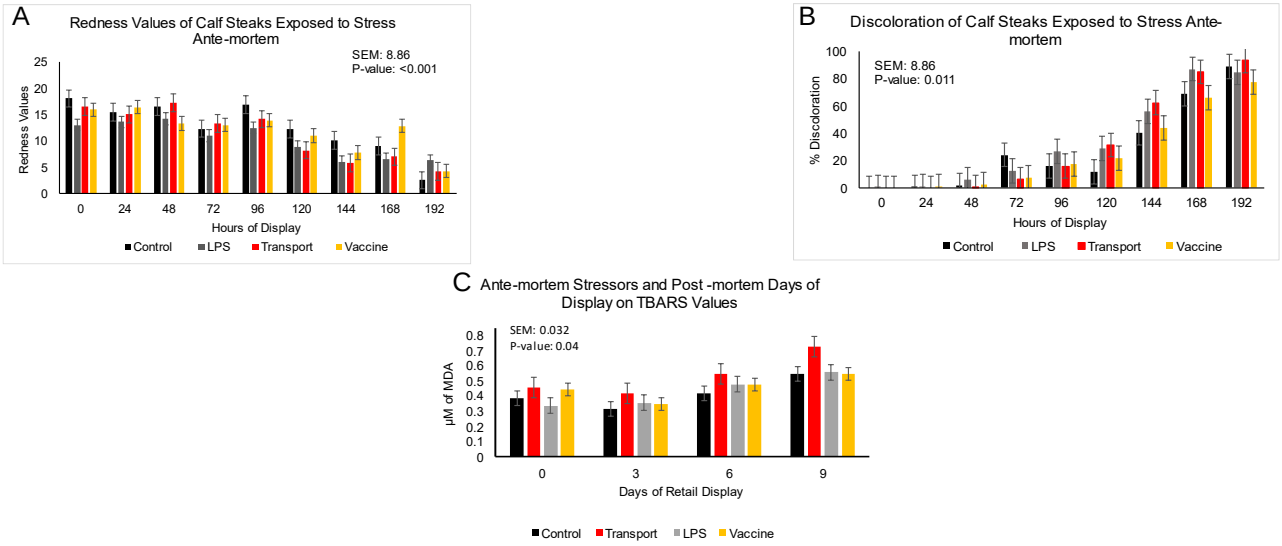

Figure 1. Ante-mortem effects of various stressors on redness (a), percent discoloration (b), and MDA concentrations determined by TBARS (c).

IV. CONCLUSION

Decreased antioxidant capacity during stress contributes to decreased ability to mitigate oxidative events in vivo. These data further suggest that when stress is not managed in the live animal, meat products may be affected by increased rates of lipid oxidation and discolouration. Transportation events prior to harvest contribute the greatest to ante-mortem stress and post-harvest deterioration, therefore further research should be done to investigate strategies minimizing oxidative stress prior to harvest to preserve meat quality attributes.

ACKNOWLEDGMENTS

S.N.B. thanks USDA-APHIS and the NBAF program at Texas Tech University.

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