

Project Summary

Vaccination Response and Weaning Stress Effects on Growth and Carcass Quality

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Background

Bovine respiratory disease (BRD) is the most common and economically draining respiratory disease present in the beef industry today, affecting all phases of the production cycle (Griffin, 1997; Holland et al., 2010). BRD causes 75% of the morbidity and accounts for up to 50% of mortality seen in feedlots (Gardner et al., 1999). The combined costs of treatment, labor needs, reduced performance, and decreased carcass quality have an estimated loss of \$750 million annually (Griffin, 1997; Holland et al., 2010). Genetic improvement for reduced BRD incidence rate is a lowly heritable trait, therefore improvement of alternative prevention may help to reduce BRD incidence (Schneider et al., 2009; Snowden, 2009). Vaccination and management practices have been identified as practical methods for reducing BRD incidence (Schneider, 2009a; Zimmerman, 2006). Therefore, immune response and timing of weanstress effects were evaluated on ultrasound traits, growth performance, and carcass composition.

Objectives:

To evaluate the effects of response to vaccination and effects of increased immune response on growth performance and carcass composition. This study had two main objectives. The first objective was to indentify the extent to which weaning-vaccination management affects beef quality and carcass traits. The second objective was to identify the extent to which individual response to vaccination impacts beef quality and carcass traits. The central hypothesis of this study was that weaning-vaccination management would have no effect on carcass quality. In contrast, performance and meat quality will be negatively impacted in animals that fail to initiate an antibody response to vaccination.

Methodology

Cattle Resource

This project utilized 1,012 registered, purebred American Angus calves from the Iowa State University breeding project. Calves were born from 2007-2009 in both spring and fall seasons. There were 137 and 197 calves in 2007, 139 and 215 calves in 2008, and 104 and 220 calves in 2009, born in fall and spring seasons, respectively. Calves were vaccinated under a two-shot protocol for bovine rhinotracheitis (IBR), bovine respiratory syncytial virus (BRSV), parainfluenza-3 (IP₃), and bovine viral diarrhea virus, types 1 and 2 (BVDV1 and 2) with Bovisheild-Gold 5 (Kalamazoo, MI). Response to vaccination was quantified as BVDV2 antibody levels in serum samples. Three 10 mL jugular blood samples were collected: at initial vaccination (initial), at booster vaccination (booster), and three weeks post booster vaccination (final). Viral neutralization assays were used to detect BVDV2 neutralizing antibodies. Effects of weanstress timing were evaluated by implementing management-induced weanstress at either the initial or booster vaccination time point.

Performance and Carcass Composition

Body composition traits were observed (n=985) at appropriate times for yearling measures. Ultrasound images were collected by an Ultrasound Guidelines Council certified field technician using a Classic Scanner 200 with ASP-18 transducer (Classic Medical, Tequesta, FL). Five measurements were collected at this time: 1) weight at yearling scan time (YWT); 2) subcutaneous fat thickness over the termination point of the biceps femoris in the rump (URFAT); 3) subcutaneous fat thickness at $\frac{3}{4}$ the lateral distance across the LM between the 12th and 13th ribs (UFAT); 4) LM

area between the 12th and 13th ribs (UREA); 5) percent intramuscular (IM) fat within the LM between the 12th and 13th ribs (UPFAT).

Performance traits evaluated were live weight at harvest (HWT) and average daily gain (ADG) from weaning to harvest. Standard carcass traits were collected by experienced individuals at 24 hours postmortem, including 1) hot carcass weight (HCW); 2) subcutaneous fat thickness at $\frac{3}{4}$ the lateral distance across the LM between the 12th and 13th ribs (CFAT); 3) LM area using plastic dot grid overlay between the 12th and 13th ribs (CREA); 4) estimated percent kidney, pelvic, and heart fat (CKPH); 5) USDA marbling score (MARB); and 6) yield grade (YG). pH was measured on steaks 48 hours postharvest. Warner-Bratzler shear force (WBSF) was evaluated for 2.54 cm thick steaks (n=576) with mean peak load (kg) as the analyzed trait.

Statistics

To evaluate the effects of response to vaccination on growth performance and carcass traits, analysis was performed using GLM in SAS version 9.2 (SAS Institute, Cary, NC). Three responses to vaccination variables were identified and evaluated, **final antibody level**, **overall response**, and **response level**. Final antibody level is defined as the total amount of antibodies in the circulatory system, including both maternal and acquired antibodies. Overall response (OR), defined as the difference between final and initial antibody level (measure of maternal antibodies present at initial vaccination). For response level animals were grouped based on overall response by non (OR antibody level less than zero), low (OR antibody level zero to five), and high (OR antibody level greater than five). The following model was used to evaluate the three responses to vaccination measurements on ultrasound traits, growth performance traits, and carcass composition:

$$y_{ijklmnopq} = T_i * WS_j + CG_k + DA_l + PE_m + Doc_n + A_q(G_o) + A_q * A_q + A_q * S_p + e_{ijklmnopq}$$

where $y_{ijklmno}$ = ultrasound, performance, or carcass quality trait measured on calf; T = antibody response variable, fit as a covariate for final antibody level and overall response, or class effect response level; T*WS = antibody level for the response studied (final antibody level, overall response, or response level) by weanstress (wean at initial or wean at booster) interaction; CG = post weaning contemporary group (year, season, gender, management group); DA = dam age (years); PE = presence of pinkeye at weaning (yes or no); and Doc = docility score for each animal at time of data collection (six pt. scale). These were fitted as class effects. Covariate fitted included: A(G) = age at scan nested within gender (bull, steer, or heifer). The error term ($e_{ijklmopq}$) was assumed to be normally distributed with mean = 0 and variance = σ_e^2 . Variables were sequentially removed based on significance (P>0.05) from the model.

Findings

Bovine respiratory disease has been shown to have deleterious effects on both performance and carcass composition traits (Gardner et al., 1999; Holland et al., 2010; Schneider, 2009b). Impacts of antibody immune response on performance and carcass traits were evaluated to identify if there were negative effects from increased antibody production. Additionally, stress effects from weaning were evaluated on the same traits. Final antibody levels, overall response, and response levels did not (P<0.05) have deleterious effects on yearling growth or ultrasound traits. YWT and URFAT were influenced (P<0.05) by final antibody level; similarly URFAT was significantly (P<0.05) impacted by response levels. Increased final antibody level by one unit increased URFAT by 0.008 cm (± 0.003 cm), while animals that responded (low or high) had increased URFAT over non-responders. Weanstress significantly impacted (P=0.01) UPFAT for final antibody level, overall

response, and response level. Animals that were weaned at the booster vaccination had increased UPFAT at yearling age: 4.42% ($\pm 0.22\%$) UPFAT compared to 4.24% (± 0.22) UPFAT in initial weaned animals. However, at harvest there were no significant differences between weanstress groups. Response level by weanstress treatment significantly ($P < 0.05$) effected HWT and ADG. Animals that were high responders and weaned at the initial vaccine had high ADG of 2.6 lb/day (**Figure 1**). A similar trend was seen in HWT, calves weaned at the initial vaccination across all response levels had increased HWT compared to calves weaned at the booster vaccination (**Figure 2**). Within the booster-weaned calves, low responders had higher performance than high or non-responders. This indicates there may be optimum antibody response levels within a given weanstress period that have increased performance advantages.

Implications

Antibody levels indicate the presences of an immune response, not necessarily the protective strength of the immune system (Chase et al., 2004). Assuming that a positive overall response to vaccination is an indication of protection induced by the vaccine, increased antibody production or overall response does not ($P < 0.05$) negatively affect growth or carcass composition. However, the interaction of response level by weanstress does impact performance traits. High responders, weaned at the initial vaccination were higher performing cattle, having increased ADG and HWT.

Therefore, increased antibody levels do not ($P < 0.05$) appear to affect growth or carcass composition. When weaning concurs simultaneously with vaccination, weaning at the initial vaccination was shown to have significantly increased growth performance over animals weaned at the booster vaccination.

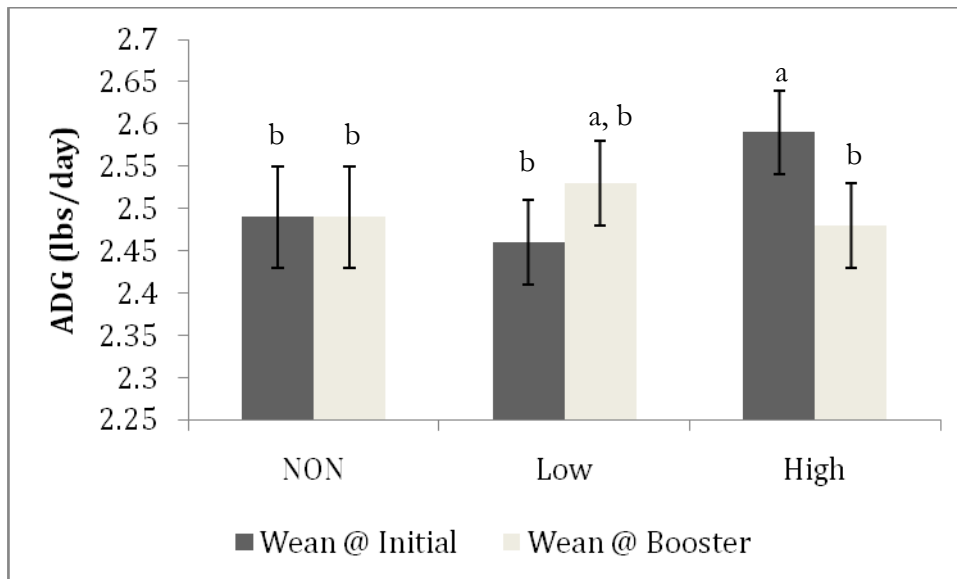


Figure 1. Effects of response group (non, low, high) by weanstress (initial or booster) on ADG (lbs/day) in harvested animals. Least square mean with different letters are statistically different ($P < 0.05$).

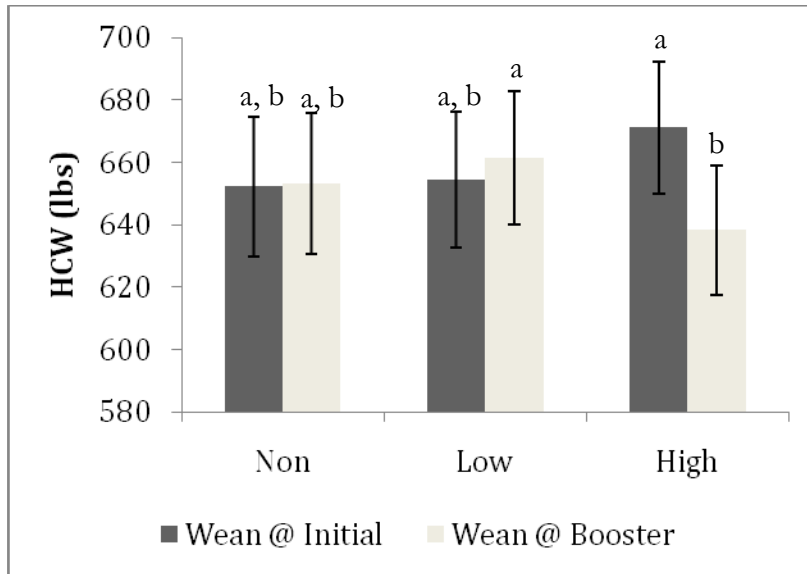


Figure 2. Effects of response level (non, low, high) by weanstress (initial or booster) on HWT (kg) at time of harvest. Least square mean with different letters are statistically different ($P < 0.05$).

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