2013

Effects of different weaning management strategies on preconditioning performance, haptoglobin serum levels, feedlot morbidity, and carcass characteristics

Jake Everitt Anderson
Louisiana State University and Agricultural and Mechanical College

EFFECTS OF DIFFERENT WEANING MANAGEMENT STRATEGIES ON PRECONDITIONING PERFORMANCE, HAPTOGLOBIN SERUM LEVELS, FEEDLOT MORBIDITY AND MORTALITY, AND CARCASS CHARACTERISTICS

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Science

in

The Interdepartmental Program in
The School of Animal Sciences

by
Jake Everitt Anderson
B.S., Louisiana State University, 2011
December 2013

ACKNOWLEDGEMENTS

I would like to extend my gratitude to my major professor Dr. Karl Harborth for allowing me the opportunity to accomplish this research. The knowledge, motivation, and enthusiasm he provided was more than enough to keep me going to the end. Thanks to him for his assistance in completing this thesis and guiding me along throughout my tenure as a graduate student at LSU.

For their support and willingness to serve as my committee members, I would like to thank Dr. Cathleen Williams, Dr. Matthew Garcia, and Dr. Ryon Walker. Thanks to Dr. Matthew Garcia and Dr. Ryon Walker for their on farm assistance in ensuring this research was handled properly. To Dr. Cathleen Williams, thank you for your advice and direction in taking classes and proper laboratory procedures. Thanks to Dr. Tim Page and the participation of the Louisiana Calf to Carcass Program and Hitch Feedlot for the collection of data during the finishing phase of this study.

I would also like to extend thanks to the staff and workers at both the Central Research Station and Hill Farm Research Station for their assistance and willingness to help with the working and care of cattle for the two years of this study. I would like to thank Mrs. Anita Canal for her assistance in processing and collecting data on the farm level. I would also like to extend gratitude to Ashley Dolejsiova for her guidance and patience teaching and assisting me in laboratory procedures. I would also like to extend thanks to the workers of the LSU Dairy Nutrition Lab for their assistance with work in the lab.

Thanks to my fellow graduate students for assisting with data and sample collection over the two years of this extensive study. Thanks to Jennifer Bailey, Tabitha Howard, Rachel Martin, Seth Mizell, and Michael Thomas for your assistance in the long days involved in data collection. Special thanks to Erica Chartier for assistance in the same, as well as assisting with sample processing in the lab, and being there throughout classes.

Finally, I would like to express the sincerest gratitude to my mother and father, Kim and Perry, for always being supportive in pursuit of my goals. I cannot express thanks enough for your continued support, advice, and love throughout my life. Thanks also to, Dianne and Frederick Spigener for your love and support and helping to inspire my initial interest in the field of cattle nutrition.

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

Weaning, one of the first major stressors encountered by the calf, has a negative effect on the immune system and increases the likelihood of infection of novel pathogens such as those that cause bovine respiratory disease. Fenceline contact at weaning has been shown to reduce the stress on the calf during the time following maternal separation. Preconditioning programs have been shown to reduce feedlot morbidity and mortality. Combining these two management practices could reduce the length of time calves need to be held in a preconditioning program. A multi-year study was conducted to evaluate if fenceline weaning will allow for a 21-d preconditioning (PRECON) period rather than a 45-d PRECON period. Two-hundred ninety-one cross-bred steer calves from two locations (Central Research Station, Baton Rouge, LA and Hill Farm Research Station, Homer, LA) were used over a two-year period. Both locations were managed independently following the same protocol. Each year, calves were stratified by BW into four treatments: 1. fenceline weaned, PRECON 21 days (FL21); 2. fenceline weaned, PRECON 42 days (FL42); 3. abrupt weaned, PRECON 21 days (S21); and 4. abrupt weaned, PRECON 42 days (S42). Calf was the experimental unit. After the initial 7 d weaning period, all calves were placed on pasture for the assigned PRECON treatment. Calves were fed an 18% CP commercial preconditioning ration at 1.5% of BW during the entire PRECON treatment period. Weight change and ADG were not different ($P > 0.05$) between all treatments during this period. Steers were transported to and managed by a commercial feedlot in Guymon, OK, until harvest. Morbidity and mortality during the feedlot period were not different ($P > 0.05$). Entry weight and ADG were not different between treatments, but FL42 and S42 calves were heavier ($P = 0.005$) and were on feed longer ($P < 0.0001$) than FL21 and S21 calves. Heavier HCW ($P = 0.005$) and greater backfat (P = 0.001) were observed in FL42 and S42, but YG, marbling score, and LM area were not different among treatments. These results are indicative that fenceline weaning does not aid in shortening the preconditioning period, and further research is needed to validate these findings.

INTRODUCTION

Bovine respiratory disease (BRD) is the most economically devastating disease to the feedlot industry (Bolte et al. 2009). BRD is characterized by infection caused by infectious bovine rhinotracheitis virus (IBRV), bovine viral diarrhea viruses 1 and 2 (BVDV1 and BVDV2), parainfluenza 3 virus (PI3V), bovine respiratory syncytial virus (BRSV), *Mannheimia haemolytica*, and *Pasteurella multicoda*. These infections are cause for decreased returns of $40.64 for calves treated once for BRD, $58.35 for calves treated twice, and $291.93 for calves treated 3 times or more, compared to calves that were not treated (Fulton et al., 2002). Bolte et al. (2009) reported several stressors associated with increases in BRD. These include stress at weaning, stress associated with introduction to an unfamiliar environment, poor intake associated with introduction to a novel feedstuffs into the animal's diet, exposure to novel pathogens upon transport to feeding facility and commingling with unfamiliar cattle, inappropriately administered respiratory disease vaccination programs, and poor response to respiratory disease vaccination programs.

Research has been conducted to evaluate the efficacy of various weaning strategies to reduce stress on the calf. One practice is fenceline weaning in which calves are placed in an adjacent pasture to their dams separated by a fence. This allows for nose to nose contact but does not allow suckling to take place (Nicol, 1977). Fenceline calves have shown greater weight gain, less time spent pacing and vocalizing, and decreased morbidity and mortality when compared to their abruptly weaned counterparts (Price et al., 2003; Boyles et al., 2007).

Another weaning alternative utilizes nose-clips placed on the calves. This allows the calves to stay with their dams, but prevents suckling due to the nose-clip (Haley et al., 2001). After dam removal, nose-clip calves have been observed to spend less time bawling and pacing, and spend more time eating than the calves without nose-clips (Haley et al., 2001, 2005).

While comparing both methods, Boland et al. (2008) observed nose-clip calves to have decreased ADG and feed intake than both abruptly weaned and fenceline weaned calves prior to weaning. After weaning, however, nose-clip and fenceline calves had greater weight gains compared to the conventionally weaned calves, with fenceline calves also gaining more than the nose-clip group.

Weaning management is only one way to alleviate the stressors caused during the post weaning period prior to feedlot transport. Another management practice is preconditioning. This practice involves keeping calves at the ranch of origin post weaning for an allotted time prior to shipping to a feedlot to increase their resistance to disease (Herrick, 1967). Research has shown that preconditioned calves had reduced incidence of BRD in the feedlot and increased ADG during the finishing phase than calves that were shipped directly to the feedlot after weaning (Cole et al., 1979; Peterson et al., 1989; Roeber et al., 2001). Also, an approximate 45 day preconditioning period has been observed to be the most beneficial to calves (Step et al., 2008; Richeson et al., 2012). Bolte et al. (2009), however, reported the possibility of shorter preconditioning times being equally beneficial.

While studies have shown that weaning management and preconditioning can alleviate stress and improve performance, little research has been conducted to study possible combined effects. Therefore, a two year multi-site study was conducted to evaluate the effects of two weaning management strategies and two preconditioning times on performance and health status during the preconditioning period, morbidity and mortality in the feedlot, feedlot performance, and carcass characteristics.

REVIEW OF LITERATURE

The goal of a commercial cow-calf operation is to produce a healthy calf crop that will grow as efficiently as possible, even after leaving the operation and entering the next phase of production. Calves are able to do this more efficiently by having stressors alleviated as much as possible. One of the first stress periods for these young animals occurs at weaning (Cole et al., 1982). Factors involved in this period include (1) maternal separation, (2) introduction to an unfamiliar environment, (3) poor intake due to introduction of novel feedstuffs into the animal's diet, (4) exposure to novel pathogens upon transport to a feeding facility and commingling with unfamiliar cattle, (5) inappropriately administered respiratory disease vaccination program, and (6) poor response to respiratory disease vaccination programs (Bolte et al., 2009). These factors can all lead to decreased production in the feeding facility, largely due to bovine respiratory disease (BRD), the most economically devastating feedlot disease (Bolte et al., 2009). Fulton et al. (2002) reported a $40.64/head decrease in return for calves treated once for BRD, $58.35/head for calves treated twice, and $291.93/head for calves treated 3 times or more, compared to calves that were not treated.

Roeber et al. (2001) studied the effects of morbidity, defined as hospital visits per calf during the feeding period, on feedlot performance, carcass characteristics, and beef palatability traits. A 12% lower ADG was observed in cattle treated for sickness more than once at the feedyard through the first 67 days compared to cattle not treated. However, average daily gain was similar when observed through the entire 185 days of the finishing period. In that study, the cattle that were treated more than once also had lower carcass weights, lower marbling scores, and lower yield grades than untreated cattle.

Waggoner et al. (2007) evaluated the records of the New Mexico Ranch to Rail Program from 2000 to 2003 for the impact of feedlot morbidity on feedlot ADG, carcass characteristics, and carcass value. Morbidity was classified as zero treatments (healthy), one medical treatment, or two or more medical treatments. The healthy steers had greater ADG and fewer days on feed than treated steers, while ADG was similar among the treated steers. Steers treated once tended to exhibit fewer days on feed compared to steers treated twice or more. No differences were observed in hot carcass weight, fat thickness, longissimus muscle area, marbling score, or calculated yield grades among healthy and treated steers, or between once and twice treated steers. Healthy steers tended to have higher priced carcasses than the treated steers, but carcass prices between treated steers did not differ. Healthy steers exhibited a higher gross income than treated steers, and steers treated once displayed greater gross income than twice treated steers.

At Kansas State University, Reinhardt et al. (2012) studied the relationship between feedlot health, ADG and carcass traits. Calves treated for disease during the finishing period were lighter upon entry to the feedlot than calves not requiring treatment. Initial BW was significantly lighter for calves treated for sickness than untreated calves, and ADG was observed to decrease linearly with increasing number of treatments for sickness. Hot carcass weight, quality grade, and yield grade all decreased linearly with increasing number of treatments. In addition, the number of treatments increased, the percentage of cattle grading Choice decreased, and the percentage of carcasses qualifying for a premium choice program was decreased.

Steers consigned to the Mississippi Farm to Feedlot Program from 1993 to 2006 were used to study steer age and morbidity effects on feedlot performance and carcass traits. A dramatic increase in morbidity rate, days treated, treatment cost, and mortality rate was observed in steers ≤180 days of age at feedlot entry than in older steers. Morbidity, days treated, treatment cost, and mortality was lowest for cattle 361 days of age or older at feedlot entry. The number of steers grading Choice or better increased with advancing calf age at time of feedlot entry. Healthy steers were older at feedlot entry and had greater initial BW than did treated steers. Marbling score, USDA QG, calculated YG, dressing percentage, and backfat thickness were greater for carcasses from healthy versus treated steers. Steers producing greater finishing net return had lower morbidity rate, days treated, and treatment cost and greater initial BW, feedlot ADG, final BW, HCW, marbling score, USDA QG, backfat thickness, LM area, LM area per unit of HCW, and calculated yield grade. (Parish et al., 2012)

Preconditioning

One way to subvert the stresses involved in the weaning period is the concept of preconditioning. This concept is defined as the time period in which calves are kept at the ranch of origin until post weaning to increase their resistance to disease (Herrick, 1967). Preconditioning has been utilized since the 1960s, as exemplified by Iowa holding their first preconditioned cattle sale in 1965, followed by Oklahoma State University holding the first national preconditioning seminar in 1967 (Tindall, 1983). Developments in the US beef industry, such as value-based marketing, food safety concerns, source verification, individual animal identification, and consolidation (at the cow-calf level) are all generally compatible with management factors involved in preconditioning (Dhuyvetter et al., 2005).

Cole et al. (1979) found a reduced number of calves treated for BRD when comparing calves weaned 30 days before leaving the farm and fed a 50% concentrate diet at the farm, 19 calves, compared with calves weaned the day of the sale, 30 calves. Cole (1985) reviewed experiments comparing preconditioned and non-preconditioned calves, and summarized that preconditioned calves showed a reduction in morbidity by 6 percentage units or 23 percent compared to non-preconditioned calves. Preconditioning also reduced feedlot mortality by 0.7 percentage units in the trials reviewed. Little significance was found, however, when comparing overall gain, average daily gain, and days on feed (Cole, 1985).

When comparing preconditioning protocols, that included timing of dehorning and castration, vaccination, and weaning, Peterson et al. (1989) found that ADG increased for calves weaned 42 days prior to shipping, compared to calves shipped immediately following weaning. Researchers also reported increased gains in groups having all stressors on the same day, as compared to dehorning, castrating, and vaccinating at varying times prior to the post weaning period. Lowest gains were observed in calves sold directly to the feedlot at time of weaning, as compared to preconditioned calves.

Feedlot performance and carcass characteristics of calves purchased from certified preconditioning programs and calves purchased from auction markets were compared in a study by Roeber et al. (2001). Morbidity rates, defined as one or more hospital visits, of 34.7%, 36.7%, and 77.3% were recorded for cattle on two certified preconditioning programs Certified Preconditioned for Health, Kentucky Cattleman's Association Certified Gold, and auction market calves, respectively. A difference of 1.1%, 1.1%, and 11.4% in mortality, was reported among the three groups. Preconditioning treatment also had a significant effect on average number of hospital visits during the finishing phase, with fewer visits being reported among preconditioning groups when compared to auction market groups. This study showed preconditioned calves had a 0.3 lb. ADG advantage during the finishing period, and 42.6 and 10.3 percentage units lower morbidity and mortality rates, respectively, than calves with an unknown history. There were no differences, however, in marbling score, yield grade, or palatability traits from the calves of both treatments (Roeber et al., 2001).

Macartney et al. (2003) compared health performance during the first 28 days in the feedlot from compared feeder calves vaccinated or preconditioned and sold in special auctions in Ontario to calves sold in traditional auctions in the province. Results revealed that vaccinated calves were 0.68 times as likely as non-vaccinated calves to be treated for BRD, and conditioned calves were 0.22 times as likely to be treated. Step et al. (2008) also found a decrease in morbidity for calves weaned 45 days before shipping. Calves preconditioned for 45 days pre-shipping and not vaccinated and calves vaccinated and preconditioned 45 days pre-shipping had feedlot morbidity levels of 5.9% and 9.5%, respectively, compared to a morbidity of 35.1% for calves sold at weaning and 41.9% for calves assembled from market. Although calf feedlot mortality did not differ significantly, calves assembled from market and those sold at weaning had 3.1% and

0.9% mortality, compared to 0.0% mortality in both preconditioning treatments (Step et al., 2008).

Bolte et al. (2009) studied length of the preconditioning period and its effects on growth, health, and carcass merit. Researchers compared separation of calves from dams for periods of 60, 45, 30, 15, or 0 days post weaning. During the first 30 days following shipping, feed intake was lower for calves weaned 0 days than for those weaned 60, 45, 30, or 15 days prior to shipping. Average daily gain and feed efficiency were similar among all groups. Percent morbidity significantly increased in calves weaned 0 days prior to shipping as compared to calves weaned 60, 45, 30, or 15 days prior to shipping. However, carcass traits did not differ among all treatments.

Holland et al. (2010) observed negative effects of bovine respiratory disease during the preconditioning phase. Heifers were arranged in the feedlot based on treatments for respiratory disease in the preconditioning phase. Heifers were grouped by never treated (0x), treated once, twice, and three times (1x, 2x, and 3x, respectively), and chronically ill (CI). As number of times treated increased, calf weight at time of feedlot receiving decreased. Using animal performance, ultrasound estimates, and visual assessment based on 12^{th} –rib fat and carcass fatness, all animals were harvested at a similar target endpoint. Final BW and HCW did not differ between treatments. Heifers treated never, once, and twice were slaughtered at an average of 163 days, as compared to 182 days for 3x heifers, and 189 days for CI heifers.

Researchers at the University of Arkansas studied the effects of preconditioned (early weaned) and auction market calves with or without exposure to a persistently infected bovine viral diarrhea virus pen mate on performance and health. Auction market calves had a 70% morbidity level compared to 7% of preconditioned calves. Daily BW gain for the entire 42-day trial was 1.2 kg for preconditioned calves as compared to 0.85 kg for auction market calves (Richeson et al., 2012).

Weaning Strategies

Weaning is one of the first stresses an animal encounters and is a physical stress that is impossible to eliminate (Cole et al., 1982). Studies have shown abrupt weaning causes elevation in cortisol, epinephrine, and norepinephrine levels (Lefcourt and Elsasser, 1995; Hickey et al., 2003). Abrupt weaning coupled with immediate transport also caused BRD induced mortality to be twice as high as compared to calves that were only subject to transport and a bacterial challenge (Hodgson et al., 2005). Lynch et al. (2010) found abrupt weaning resulted in an increase in neutrophil counts and also impaired phagocytic function. Alternative weaning methods for abating this stress have been explored in recent years and are slowly being implemented in the industry.

Fenceline weaning is a weaning method by which the calf and dam are placed in separate but adjacent pastures. This allows for vocal, visual, and nose-to-nose contact between the calf and the dam, but does not provide opportunity for the calf to suckle (Nicol, 1977). Nicol (1977) studied this method compared to the traditional method of abruptly removing the calf from the dam. No weight difference was observed between the two groups, two and five days, after weaning; however, traditionally weaned calves weighed less than fenceline calves one day after weaning. Similar results were also reported by Stookey et al. (1997), where no weight differences was observed between fenceline and standard groups after day three. This study, however, also tested differences of behavior indicators of stress. Standard weaned calves stood up, walked and vocalized more often on day one and two than fenceline weaned calves.

Price et al. (2003) further studied fenceline weaning with the addition of an un-weaned control group. Researchers examined behavioral indices of distress, such as time eating, time spent walking (pacing), time lying down, and weight gain for a 7 day period. Treatment comparisons included calves separated from dam by fenceline in separate pasture, total separation on pasture, total separation in drylot and fed hay, total separation in drylot and not fed hay, and an un-weaned control group. The fenceline pasture and control groups spent more time eating as compared to the other groups. Calves totally pasture separated spent more time pacing than calves in the other groups; they also spent less time lying down than fenceline, control, and drylot hay fed calves. Fenceline weaned calves also spent less time vocalizing than calves totally separated by pasture and calves separated in a drylot without hay. Greater cumulative post-weaning gains were recorded for fenceline weaned calves compared to all three totally separated treatments. They also gained 95% more weight on average in the first two weeks of the study and were heavier at the end of the 10 week trial compared with the dry lot and control groups (Price et al., 2003).

Boyles et al. (2007) researched the benefits of fenceline weaning on performance factors of calves, as well as health of calves during the 28 day feedlot receiving period. This study compared three treatments: calves weaned at time of transport, calves weaned 30 days before transport and confined in a drylot, and calves weaned 30 days before transport and pastured with fenceline contact with their dams. Calves weaned at transport and fenceline calves had increased ADG compared to drylot calves. Dry matter intake was increased for fenceline and drylot calves compared to calves weaned at transport. Morbidity in the feedlot was decreased in fenceline weaned calves, with 15% as compared to 28% and 38% morbidity for calves weaned at transport and drylot calves, respectively.

Another alternative to the standard weaning process is the two-stage weaning process. This was developed by researchers at the University of Saskatchewan and involves the use of nose-plates fitted to the calf prior to weaning. These plates keep the calf from nursing, but do not require separation from the dam (Haley et al., 2001). In a study conducted by Haley et al. (2001) observed differences in behavior between calves fitted with this device for a four day period and calves allowed to nurse freely. After the four day period, all calves were removed from their dams and observed for an additional four day period. During the four day period following weaning, calves fitted with the nose-plates vocalized 84% less, walked 79% less, and spent 24% more time eating than control calves.

Haley et al. (2005) once again studied differences between nose-plate fitted calves and standard weaned calves. After separation from the dams, calves that were fitted with the nose-plates were observed vocalizing 96.6% less, spent 78.9% less time bawling, 23.0% more time eating, and spent 24.1% more time resting than the control calves. The two-stage calves had a lower ADG prior to separation; however, ADG increased after maternal separation, as compared to the control group. Overall, calves from the two-stage treatment were less distressed after maternal separation than control calves, but overall ADG did not differ between treatments (Haley et al., 2005).

Boland et al. (2008) compared fenceline and nose-plate weaning to the standard abrupt weaning. Nose-plate calves spent less time eating, more time idling, more time close to dams, less time walking, and had reduced ADG compared to the fenceline and abrupt weaned groups in the 7 days prior to shipping. After transport, the abrupt weaned calves spent less time eating, more time idling, and more time walking than both fenceline and nose-plate calves. Average daily gain was greater for fenceline calves than for nose-clip calves. Nose-plate calves also had elevated levels of NEFA and reduced concentrations of creatine kinase (CK) and BUN. Elevated NEFA and BUN levels have been linked to decreased feed intake (Ellenberger et al., 1989; Kannan et al., 2002), CK is released in response to stress or muscle damage (Tarrant, 1990).

Economics of Preconditioning

A major factor governing the mass acceptance of preconditioning into industry practice is economics (Cole, 1985). Many factors affect these economic conditions, with feed costs, vaccination costs, premiums for preconditioning, weight at sale and time of sale affecting the marketing of feeder calves. The profitability of preconditioning varies by ranch and is dependent on market conditions and feed/forage resources. Cole (1985) found variable profitability when reviewing previous studies on preconditioning. Break even costs were higher for calves in a preconditioning program, but were subject to some premiums. Cole (1985) also identified the major factors limiting the acceptance of preconditioning were facilities, labor, and capital requirements.

Roeber and Umberger (2002) assessed the value of preconditioning programs in beef production systems. Total revenue was found to be increased by $46.83/head and

$49.53/head for calves in two certified preconditioning programs when compared to calves from unknown origin. This calculated to an additional $8.50/cwt and $9.00/cwt more per 550 pound calf that feedlot operators could pay for preconditioned calves and still remain profitable.

Researchers at Mississippi State University investigated the value of low input grazing preconditioning versus high input drylot confined preconditioning. Net monetary returns of $46.38, $3.21, and $18.25 per head were reported for calves preconditioned on ryegrass, drylot fed at 4.54 kg of grain/head per day, and drylot fed at 2.27 kg of grain/head per day, respectively. Superior ADG (1.33 versus 0.84 and 0.89) and reduced feed costs favored the ryegrass treatment over dry lot for preconditioning (St. Louis et al., 2003).

Avent et al. (2004) performed a review of previous research to evaluate the market of preconditioned feeder calves. Preconditioned calves were found to be healthier, with a stronger immune system, resulting in more value to feeder cattle buyers than non-preconditioned calves. Feedlot managers have indicated a significant perceived performance difference favoring preconditioned cattle. Benefits were expected for death loss percentage, percentage of sick cattle, average daily gain, feed efficiency, and carcass traits (percent grading choice, and carcasses that were severely discounted). These differences increased the perceived value of preconditioned calves for feedlot managers by $5.25/cwt. Data from two preconditioning sales showed price premiums of $3.30/cwt and $1.94/cwt. The first sale was a single protocol preconditioning program as compared to the multiple guidelines set forth in the second sale. Although buyers paid premiums for preconditioned cattle, overall results showed variability in profitability for preconditioning programs, and this variability was derived from the increased cost involved in preconditioning (Avent et al., 2004).

Haptoglobin as an Indicator of BRD

In the aftermath of injury, trauma, or infection of a tissue, the host executes a complex series of reactions in an effort to prevent ongoing tissue damage, isolate and destroy the infective organism, and activate the repair processes that are necessary to return the host to normal function. This cumulative homeostatic process is known as inflammation, and the early and immediate set of reactions that are induced are known as the acute phase response. This response is initiated at the site of infection and inflammation and causes a cascade of events that includes the release of mediators known as acute phase proteins. These proteins include α_1-acid glycoprotein (AGP), serum amyloid A (SAA), C-reactive protein (CRP), complement component C3, and haptoglobin, depending on the species of origin (Baumann and Gauldie, 1994).

Murata et al. (2004) reviewed current research with acute phase proteins in veterinary diagnoses. They found haptoglobin and SAA to be the major acute phase proteins in ruminant species. Major acute phase protein was defined as increasing 10 to 100-fold in response to stimuli. Eckersall and Bell (2010) reported serum concentrations of haptoglobin to be < 20 mg/L in healthy cattle, but can increase to > 2 g/L within 2 days of infection. Researchers at the University of Saskatchewan measured haptoglobin in calves infected with bovine respiratory disease. Haptoglobin concentrations were greater in calves that died from respiratory infection, compared to calves that survived. Haptoglobin was also highly correlated with subjective clinical examination (sick score), body temperature, weight change, and plasma zinc concentration (Godson et al., 1996). Heegaard et al. (2000) detected haptoglobin levels to peak in calves around 7-8 days after aerosolized and intratracheal injection with bovine respiratory syncytial virus infected fetal bovine lung cell cultures, compared with calves that were mock-infected (uninfected cultures) controls. The magnitude and the duration of the haptoglobin were strongly correlated with the severity of clinical signs (fever) and with the extent of lung consolidation.

Haptoglobin was utilized by Carroll et al. (2009) to evaluate the acute-phase reaction in response to a challenge of a lipopolysaccharide, *Escherichia coli*, at 295 days of age in beef calves weaned at 80 days of age and 250 days of age. Calves weaned at 80 days of age had lower average haptoglobin concentrations compared to 250 day weaned calves. Calves at the Swedish University of Agricultural Sciences were observed for disease incidence and sampled for haptoglobin. Calves with higher disease incidence had significantly lower mean weight gain and elevated serum acute phase protein concentrations. The mean maximum concentration of haptoglobin was observed to be greater in the higher disease incidence calves as compared to the healthy calves (Ganheim et al., 2007).

Burciaga-Robles et al. (2009) studied haptoglobin as a diagnostic tool for bovine respiratory disease. Three-hundred and thirty-seven heifer calves were evaluated for BRD during a 42 day feedlot receiving period. Haptoglobin concentration was greatest (3.01 mg/ml) on the day prior to receiving. Day 0 was dedicated to unloading and processing of calves where calves received vaccinations for BRD. Haptoglobin concentrations continued to decrease as days in the feedlot increased, 0.17 mg/ml on day

42. Haptoglobin levels were greatest in calves treated for BRD once versus calves treated for BRD three times. When comparing calves that were healthy versus sick, haptoglobin was lower in healthy animals compared with sick animals.

Holland et al. (2011) evaluated serum haptoglobin concentrations at feedlot arrival and subsequent feedlot performance and morbidity and mortality rates of calves that developed bovine respiratory disease. In the first experiment calves were divided into groups of low (<1.0 μg/ml), medium (1.0 to 3.0 μg/ml), or high (>3.0 μg/ml) serum haptoglobin concentrations. The second experiment grouped calves by detectable or undetectable levels of serum haptoglobin concentrations. Calves with low or medium haptoglobin concentrations had greater ADG (0.58 and 0.77 kg/day, respectively) than calves with high concentrations (0.17 kg/day) in the initial 7 days after feedlot arrival. However, ADG did not differ throughout the entire 63 day evaluation period. Dry matter intake was greater in the low and medium haptoglobin groups, 3.37 and 3.30 kg/day, respectively, than in the high group, 2.74 kg/day for the first 7 days. The low group also had greater DMI than the high group for the first 21 days; however, DMI did not differ between haptoglobin concentration groups through day 63. Total morbidity and mortality did not differ between haptoglobin concentrations; however, percentage of calves requiring three treatments was higher in the medium and high haptoglobin groups, 25.09% and 28.12%, respectively, than in the low group, 10.43%. Carcass characteristics were not different among calves in the three haptoglobin groups.

In the second experiment, Holland et al. (2011) grouped calves as either having or not having detectable levels of haptoglobin. Body weight at arrival was greater for calves with no detectable concentration than calves with a detectable concentration. This difference remained for the 42 day trial, 278 kg for non-detectable and 266 kg for detectable concentrations. Average daily gain and DMI over the 42 days were greater in calves with non-detectable concentrations, 0.80 kg/day ADG and 5.78 kg/day DMI, than calves with detectable concentrations, 0.74 kg/day ADG and 5.19 kg/day DMI. Percentage of calves requiring 3 treatments for illness was greater in calves with detectable haptoglobin concentrations than calves with non-detectable concentrations. Number of days until first treatment for BRD was also greater in calves with detectable concentrations, 5.4 days, than calves with non-detectable concentrations, 8.5 days.

MATERIALS AND METHODS

Animals and Treatments

From 2011-2012, two spring calf crops of (n=291) crossbred steer calves, 252.9 kg, were utilized to compare two weaning methods and two preconditioning times at two Louisiana locations. The Central Station (CS) Research Facility in Baton Rouge, Louisiana, provided 74 calves in 2011 and 68 calves in 2012, and the Hill Farm (HF) Research Station in Homer, Louisiana, provided 76 calves in 2011 and 73 calves in 2012. All animal handling and experimental procedures were approved by the Institutional Animal Care and Use Committee of the LSU Agricultural Center. Calves originated from the CS and HF station herds and were born in the springs of 2011 and 2012. Calves were castrated at birth and dehorned the summer before weaning in early October. Calves were administered a preweaning modified live vaccine for strains of IBR, BVD 1, BVD 2, PI3, and BRSV prior to weaning (Bovishield Gold 5, Zoetis, Florham Park, NJ) and a vaccine against Clostridium chauvoei, septicum, novyi, sordelli and Clostridium perfringens Type C & D (Vision 7, Merck Animal Health, Summit, NJ).

Weaning Phase

Calves were stratified by weight into four treatments including fenceline weaned, preconditioned for 21 days (FL21); fenceline weaned, preconditioned for 42 days (FL42); standard weaned, preconditioned for 21 days (S21); and standard weaned, preconditioned for 42 days (S42). Calves were weighed at day -7, standard wean (S) calves were placed back with their dams, and fenceline (FL) calves were placed in a pasture adjacent to dams, allowing nose-to-nose contact with the dams but preventing suckling. At day 0, all calves were weighed and S calves were placed in a pasture with the FL calves. All dams were then moved to a pasture isolated from calves, with no nose-to-nose contact.

Preconditioning Phase

Calves were raised on mixed Bermudagrass (*Cynodon dactylon*) with free choice water. Calves were supplemented a 12% CP preconditioning ration (Table 1-1) (Lonestar Precon/Recon, Texas Farm Products Company, Nacogdoches, TX) at 1.5% BW daily. Calves were also supplemented with free choice Bermudagrass (*Cynodon dactylon*) hay (6.42 CP at CS and 8.71 CP at HF) (Table 1-2) in the 2011 year due to lack of forage due to drought. On day 21, calves were again weighed and S21 and FL21 calves were shipped to a commercial feedlot in Guymon, Oklahoma, for finishing. Similarly, S42 and FL42 calves were weighed and shipped on day 42. Feed and hay samples were analyzed via wet chemistry (SDK Laboratories, Hutchinson, KS).

Table 1. Lonestar Precon/Recon®-Preconditioning diet analysis for both Central Station and Hill Farm Station groups for 2011 and 2012.

Nutrient Composition, % DM	%
DM	94.27
CP	13.46
ADF	32.16
NDF	48.74
NE gain	0.35
TDN	60.95
Ca	2.00
P	0.64
Lasalocid	30 g/ton
Oxytetracycline	7.5 g/ton

Table 2. Bermudagrass hay analysis for Central Station and Hill Farm Station groups for 2011.

	Central Station (2011)	Hill Farm (2011)
Nutrient Composition, % DM	%	%
DM	90.75	89.13
CP	6.42	8.71
ADF	48.71	35.81
NDF	72.44	59.22
NEm	0.22	0.50
NEg	0.00	0.25
TDN	36.79	54.20
Ca	0.43	0.49
P	0.19	0.28

Finishing Phase

Calves were finished at a commercial feedlot (Hitch Enterprises, Guymon, Oklahoma) where feedlot performance data were collected in conjunction with the Louisiana Calf to Carcass Program. Calves were weighed upon feedlot arrival. Data collected from the feedlot included entry weight, finishing weight, ADG, morbidity, and mortality. Morbidity was analyzed as either treated for sickness or not treated. Likewise for mortality, steers received a score of one if they died.. Cattle were harvested at the discretion of the feedlot manager based on market readiness and market conditions. Carcass data included hot carcass weight, yield grade, marbling, LM area, backfat, and carcass yield grade.

Blood Collection and Laboratory Methods

Blood samples were collected via jugular or tail venipuncture into 10-ml evacuated tubes (B.D., Franklin Lakes, N.J.) on days -7, 0, 21, and 42 of the weaning and preconditioning phases and analyzed for serum bovine haptoglobin. Samples were centrifuged at 2,000 rpm for 20 minutes and serum was removed and stored at -80 C until analysis. Serum haptoglobin concentrations were measured using a commercially available enzyme immunoassay for the quantitative determination of bovine haptoglobin in serum (Life Diagnostics, Inc., West Chester, PA).

Statistical Methods

Data were analyzed using PROC Mixed procedure (version 9.1.3, SAS Inst. Inc., Cary, NC). Calf was the experimental unit. Preconditioning performance, morbidity and mortality, feedlot performance, carcass characteristics, and serum haptoglobin concentrations were fit as random variables in the model. Treatment, site, and year were fitted as fixed variables. Year was nested within site as a random variable to account for confounding effects of year and site. The PROC CORR procedure (version 9.1.3, SAS Inst. Inc., Cary, NC) was used to calculate Pearson correlation coefficients between the random variables of day of serum haptoglobin sampling and feedlot morbidity and mortality. Significance was determined at $P < 0.05$, and trends were set at $P < 0.1$.

RESULTS AND DISCUSSION

On Farm Performance

Least squares means for pre-weaning weight, weaning weight, ADG during the weaning period, weight at shipping, and ADG during the preconditioning period are reported in Table 2-1. No differences were seen in weaning weights (day -7 and day 0) and ADG during weaning for all treatments ($P > 0.05$). Boland et al. (2008) reported no weight differences between fenceline and abrupt weaning during a 7 day fenceline weaning period. No differences were observed for shipping weight and ADG during the preconditioning period ($P > 0.05$). Research reported by Bolte et al. (2009) differs observing a trend for ADG to linearly increase in calves preconditioned for longer periods of time. Nicol (1977) reported no weight difference between fenceline separated calves and abrupt weaned calves up to 20 days after weaning. Price et al. (2003) reported increased weight gain 2 weeks and 10 weeks after weaning in calves allowed fenceline contact with dams as compared to calves enduring total dam separation.

Table 3. Effects of weaning management strategy and length of preconditioning period on preconditioning performance of crossbred steer calves.

	Fenceline Wean		Standard Wean		SEM	P-value
	21d	42d	21d	42d		
Pre-weaning BW (kg)	253.40	253.59	254.92	252.33	3.58	0.97
Day -7 weight[2] (kg)	261.26	258.60	261.18	260.14	11.09	0.95
Day 0 weight[3] (kg)	266.95	265.60	268.19	265.83	8.50	0.96
ADG weaning (kg)	0.81	1.00	0.95	0.80	0.47	0.90
Shipping weight (kg)	264.80	272.08	267.58	272.80	7.92	0.49
ADG preconditioning (kg)	0.04	-0.15	0.03	-0.15	0.11	0.41

[1]21d=21 day preconditioning period, 42d=42 day preconditioning period.
[2] Weight at time of fenceline weaning.
[3] Weight at time of abrupt weaning.

Feedlot Morbidity and Mortality

Morbidity and mortality data were analyzed for the finishing period. Morbidity was defined as requiring treatment and mortality was defined as death loss. Morbidity and Mortality results within treatment are reported in Table 2-2. Morbidity and mortality did not differ between treatments ($P > 0.05$). Previous research has indicated that morbidity is decreased when calves are weaned by the fenceline method. Boyles et al. (2007) reported calves that were allowed fenceline contact during the weaning period with a 30 day preconditioning time prior to shipping also had a decreased feedlot morbidity (15%) when compared to calves abruptly weaned and shipped to feedlot (28%) and calves weaned with no dam contact and preconditioned in a drylot for 30 days prior to shipping (38%). Preconditioning has also been shown to decrease morbidity. Cole et al. (1979) reported a decrease in the number of animals treated for calves weaned 30 days prior to shipping, 19 calves treated for disease, compared to animals that were shipped immediately after weaning, 30 calves treated for disease, but Cole et al. (1982) observed no differences in morbidity and mortality in calves weaned 30 days prior to shipping, compared to calves weaned at shipping. Step et al. (2008) indicated a decrease in morbidity for calves subjected to a 45 day preconditioning period, 5.9%, compared to calves weaned immediately prior to shipping, 35.1%, but reported no mortality differences among treatments.

Table 4. Effects of weaning management strategy and length of preconditioning period on morbidity and mortality of crossbred steer calves during the feedlot period.

	Fenceline Wean		Standard Wean		SEM	P-value
	21d[1]	42d[1]	21d[1]	42d[1]		
Morbidity[2], %	0.34	0.38	0.28	0.26	0.05	0.22
Mortality[3, 4], %	0.04(3)	0.01(1)	0.05(4)	0.06(4)	0.04	0.54

[1] 21d=21 day preconditioning period, 42d=42 day preconditioning period
[2] Morbidity defined as requiring treatment for disease, percentage of calves within treatment group requiring treatment
[3] Mortality defined as found dead, percentage of calves within treatment group that died
[4] Number in parentheses indicates actual number within treatment.

Shrink and Feedlot Performance

Results for percent shrink, feedlot entry weight and final weight, days on feed, and ADG are reported in Table 2-3. Shrink percentage was lower (P = 0.001) for FL21 and S21 calves, 3.72% and 3.20% respectively, compared to FL42 and S42 calves, 7.02% and 8.04% respectively. This may be attributed to the fact that FL42 and S42 calves were preconditioned longer, potentially having a more consistent gut fill, which would give these calves more potential for shrink loss. Cole et al. (1979) and Boyles et al. (2007) both reported no shrink differences in calves subject to a preconditioning period, compared to calves shipped subsequently to weaning. Feedlot entry weight did not differ between treatments (P > 0.05). Final weight was higher (P = 0.005) for FL42 and S42 calves, 597.03 kg and 597.04 kg respectively, compared to FL21 and S21 calves, 571.40 kg and 579.17 kg respectively. This could be attributed to the greater days on feed of the FL42 and S42 calves. Step et al. (2008) reported no BW differences after the 42 day receiving period and ADG that period for calves subject to a 45 day preconditioning period, versus calves shipped immediately following weaning. No differences between treatments were observed for ADG. Bolte et al. (2009) reported calves that were preconditioned for longer periods of time tended to have a higher ADG in the feedlot. Calf BW from receiving to 114 days in the feedlot also increased linearly for calves with longer precondition periods. Days on feed was higher (P < 0.0001) for FL42 and S42 calves, 192.24 days and 192.34 days respectively, compared to FL21 and S21 calves, 183.50 days and 183.35 days respectively. Bolte et al. (2009) showed days on feed to decrease linearly as calves were preconditioned for longer periods of time. This differs with the current study, where days on feed increased as calves were preconditioned for a longer period of time.

Table 5. Effects of weaning management strategy and length of preconditioning period on feedlot performance of crossbred steer calves during the feedlot period.

	Fenceline Wean		Standard Wean		SEM	P-value
	21d[1]	42d[1]	21d[1]	42d[1]		
Shrink %	3.72[a]	7.02[b]	3.20[a]	8.04[b]	1.03	0.001
Entry Weight (kg)	256.00	254.40	260.83	255.63	7.21	0.64
Final Weight (kg)	571.40[a]	597.03[b]	579.17[a]	597.04[b]	7.89	0.005
Days on Feed	183.50[a]	192.24[b]	183.35[a]	192.34[b]	0.69	< 0.0001
ADG (kg)	3.84	3.97	3.88	3.96	0.06	0.30

[1] 21d=21 day preconditioning period, 42d=42 day preconditioning period

[a, b] Means within a row with different superscripts are different (P < 0.05).

Carcass Characteristics

Results for carcass characteristics are reported in Table 2-4. Hot carcass weight was greater (P = 0.005) in FL42 and S42 calves, 386.90 kg and 382.67 kg respectively, compared to FL21 and S21 calves, 367.17 kg and 368.90 kg respectively. No differences were observed between treatments for YG, marble score, and LM area. Backfat was greater (P = 0.001) in FL42 and S42 calves, 0.51 cm and 0.53 cm respectively, compared to FL21 and S21 calves, 0.41 and 0.45 respectively. However, Van Koevering et al. (1995) observed a positive correlation of days on feed to HCW and backfat, so this could potentially account for some of these differences. Step et al. (2008) reported a yield grade decrease in calves preconditioned for 45 days, 2.33, compared to calves shipped immediately after weaning, 2.77. Bolte et al. (2009) showed no differences in HCW, marbling, and LM area for calves preconditioned for varying amounts of time; whereas, yield grade increased linearly with longer preconditioning periods, and fat thickness showed a tendency to increase as calves were subjected to a longer preconditioning time.

Table 6. Effects of weaning management strategy and length of preconditioning period on carcass characteristics of crossbred steer calves.

	Fenceline Wean		Standard Wean		SEM	P-value
	21d[1]	42d[1]	21d[1]	42d[1]		
HCW (kg)	367.17	386.33	368.90	382.67	6.54	0.005
YG	2.31	2.64	2.50	2.63	0.11	0.11
Marble Score[2]	524.00	547.88	536.29	559.57	18.38	0.11
LM area (cm)	13.77	13.71	13.28	13.72	0.20	0.25
Backfat (cm)	0.41	0.51	0.45	0.53	0.02	0.001

[1]21d=21 day preconditioning period, 42d=42 day preconditioning period

[2] 400 = slight; 500 = small; 600 = modest

[a, b] Means within a row with different subscripts are different (P < 0.05).

Serum Haptoglobin Concentrations

Serum haptoglobin concentrations are shown in Table 2-5. For all four time points (day -7, 0, 21, and 42) no differences in serum haptoglobin concentration were observed (P > 0.05). Although no studies have looked at differences between weaning and preconditioning strategies, research has been done to show the effect various stressors have on haptoglobin concentrations. Carroll et al. (2009) saw an increase in haptoglobin for calves weaned at 250 days of age as compared to calves weaned at 80 days. Hickey et al. (2003) and Lynch et al. (2010) both showed no effect of abrupt weaning on haptoglobin concentration. Step et al. (2008) did show a decrease in serum haptoglobin for calves weaned and preconditioned for 45 days as compared to calves weaned and shipped directly to the feedlot.

Serum haptoglobin concentrations also showed no correlation to morbidity and mortality. Pearson correlation coefficients for serum haptoglobin concentrations and morbidity and mortality are reported in Table 2-6. Burciaga-Robles et al. (2009) reported an increase in haptoglobin between feedlot calves that were deemed healthy, compared to calves that required treatment, suggesting relation to feedlot morbidity and increased haptoglobin levels. Burciage-Robles et al. (2009) also reported haptoglobin to decrease as number of times treated increased, suggestion haptoglobin to be related more to acute infection, rather than chronic infection.

Table 7. Effects of weaning management strategy and length of preconditioning period on serum haptoglobin concentration of crossbred steer calves.

	Fenceline Wean		Standard Wean		SEM	P-value
	21d[1]	42d[1]	21d[1]	42d[1]		
Day -7[3] (μ/ml)	24.78	13.34	11.32	14.50	7.27	0.25
Day 0[4] (μ/ml)	14.02	10.78	7.94	9.19	5.79	0.78
Day 21 (μ/ml)	11.63	15.59	15.83	13.52	4.25	0.87
Day 42 (μ/ml)	…[2]	31.89	…[2]	21.28	10.65	0.42

[1] 21d=21 day preconditioning period, 42d=42 day preconditioning period

[2] 21d preconditioned calves were already shipped and unavailable for sampling.

Table 8. Correlation coefficients of serum haptoglobin concentrations of crossbred steer calves and morbidity and mortality in the finishing phase.

Variable	D 0[b]	D21[c]	D 42[d]	Morbidity[e]	Mortality[f]
D -7[a]	0.114	-0.039	-0.019	-0.013	-0.056
	0.07	0.53	0.84	0.77	0.36
D 0[b]		0.008	0.036	0.001	0.002
		0.90	0.69	0.98	0.98
D 21[c]			-0.003	-0.018	0.085
			0.98	0.77	0.17
D 42[d]				0.126	0.011
				0.15	0.90
Morbidity[e]					0.127
					0.03

[a] Serum haptoglobin concentration 7 days prior to weaning.
[b] Serum haptoglobin concentration at time of weaning.
[c] Serum haptoglobin concentration after 21d preconditioning.
[d] Serum haptoglobin concentration after 42d preconditioning.
[e] Defined as treated for disease in feedlot.
[f] Defined as found dead in feedlot.

SUMMARY AND CONCLUSIONS

Many studies have indicated that fenceline weaning decreases the stress on calves brought on by weaning. Studies have also indicated that calves perform better in the feedlot if they are subject to a preconditioning program. An experiment was conducted to determine the effects of fenceline weaning on the length of preconditioning.

No differences were observed in performance during the weaning and preconditioning periods. These results from this study do not indicate an advantage of fenceline weaning or a longer preconditioning time on the performance of calves during this period of time. Morbidity and mortality during the feedlot period also did not differ between treatments. Results from feedlot performance observations did reveal differences in treatments. There were no differences between treatments for shrink percentage, initial feedlot weight, and ADG during the feedlot period. However, calves subject to either 42 day preconditioning treatments had a higher percent shrink, a higher final weight, and a higher days on feed, compared to calves subject to either of the 21 day preconditioning treatments. There were no differences in YG, marbling score, and LM area, but significant differences were observed in HCW and backfat as 42 day preconditioning calves had higher HCW and backfat, compared to their 21 day preconditioning treatment counterparts. This most likely can be attributed to the number of days on feed.

These results do not indicate that fenceline weaning is beneficial in shortening the preconditioning process and further research should be conducted to validate these findings.

REFERENCES

Avent, K.R., C.E. Ward, and D.L. Lalman. 2004. Market Valuation of preconditioning feeder calves. J. Agri. and Applied Econ. 36.1:173-183.

Baumann, H. and J. Gauldie. 1994. The acute phase response. Immunol Today. 2:74-80.

Boland, H.T., G. Scaglia, W.S. Swecker Jr., and N.C. Burke. 2008. Effects of alternate weaning methods on behavior, blood metabolites, and performance of beef calves. Prof Anim Sci. 24:539-551.

Bolte, J.W., K.C. Olson, J.R. Jaeger, T.B. Schmidt, D.U. Thomson, B.J. White, R.L. Larson, N.A. Sproul, L.A. Pacheco, and M.D. Thomas. 2009. Length of the weaning period affects postweaning growth, health, and carcass merit of ranch-direct beef calves weaned during the fall. Paper presented at Cattlemen's Day, Kansas State University, Manhattan, KS. Kansas State University. Agriculture Experiment Station and Cooperative Extension Service.

Boyles, S.L., S.C. Loerch, and G.D. Lowe. 2007. Effects of weaning management strategies on performance and health of calves during feedlot receiving. Prof. Anim. Sci. 23:637-641.

Burciaga-Robles, L.O., B.P. Holland, D.L. Step, C.R. Krehbiel, G.L. McMilen, C.J. Richards, L.E. Sims, J.D. Jeffers, K. Namjou, and P.J. McCann. 2009. Evaluation of breath biomarkers and serum haptoglobin concentration for diagnosis of bovine respiratory disease in heifers newly arrived at a feedlot. Am. J. Vet. Res. 270:1291-1298.

Carroll, J.A., J.D. Arthington, and C.C. Chase, Jr.. 2009. Early weaning alters the acute-phase reaction to an endotoxin challenge in beef calves. J. Anim. Sci. 87:4167-4172.

Cole, N.A., J.B. McLaren, and M.R. Irwin. 1979. Influence of pretransit feeding regimen and posttransit B-vitamin supplementation on stressed feeder steers. J. Anim. Sci. 49:310-317.

Cole, N.A., J.B. McLaren, and D.P. Hutcheson. 1982. Influence of preweaning and b-vitamin supplementation of the feedlot receiving diet on calves subjected to marketing and transit stress. J. Anim. Sci. 54:911-917.

Cole, N.A. 1985. Preconditioning calves for the feedlot. Vet. Clin. North Am. Food. Anim. Pract. 1(2):401-11.

Dhuyvetter, K.C. A.M. Bryant, and D.A. Blasi. 2005. Case Study: Preconditioning beef calves: Are expected premiums sufficient to justify the practice? Prof. Anim. Sci. 21:502-514.

Eckersall, P.D. and R. Bell. 2010. Acute phase proteins: Biomarkers of infection and inflammation in veterinary medicine. The Vet. Journal. 185:23-27.

Ellenberger, M.A., D.E. Johnson, G.E. Carstens, K.L. Hossner, M.D. Holland, T.M. Nett, and C.F. Nockels. 1989. Endocrine and metabolic changes during altered growth rates in beef cattle. J. Anim. Sci. 67:1446.

Fulton, R.W., B.J. Cook, D.L. Step, A.W. Confer, J.T. Saliki, M.E. Payton, L.J. Burge, R.D. Welsh, and K.S. Blood, 2002. Evaluation of health status of calves and the impact on feedlot performance: Assessment of a retained ownership program for postweaning calves. Can. J. Vet. Res. 66:173-180.

Ganheim, C., S. Alenius, and K.P. Waller. 2007. Acute phase proteins as indicators of calf herd health. The Vet. Journal. 173:645-651.

Godson, D.L., M. Campos, S.K. Attah-Poku, M.J. Redmond, D.M. Cordeiro, M.S. Sethi, R.J. Harland, L.A. Babiuk. 1996. Serum haptoglobin as an indicator of the acute phase response in bovine respiratory disease. Vet. Immun. and Immunopath. 51:277-292.

Haley, D.B., J.W. Stookey, J.L. Clavelle, and J.M. Watts. 2001. The simultaneous loss of milk and maternal contact compounds distress at weaning in beef calves. Page 41 in Proc. 35th Int. Cong. Int. Soc. Appl. Ethol. J.P. Garner, J.A. Mench, and S.P. Heekin, ed. Davis, CA. The Center for Animal Welfare, University of California, Davis.

Haley, D.B., D.W. Bailey, and J.M. Stookey. 2005. The effects of weaning beef calves in two stages on their behavior and growth rate. 83:2205-2214.

Heegaard, P.M.H., D.L. Godson, M.J.M. Toussaint, K. Tjornehoj, L.E. Larsen, B. Viuff, L. Ronsholt. 2000. The acute phase response of haptoglobin and serum amyloid A (SAA) in cattle undergoing experimental infection with bovine respiratory syncytial virus. Vet. Immun. and Immunopath. 77:151-159.

Herrick, J.B. 1967. Preconditioning feeder cattle. Preconditioning Seminar Proc., Oklahoma State University, Stillwater.

Hickey, M.C., M. Drennan, and B. Earley. 2003. The effect of abrupt weaning of suckler calves on the plasma concentrations of cortisol, catecholamines, leukocytes, acute-phase proteins and in vitro interferon-gamma production. J. Anim. Sci. 81:2847-2855.

Hodgson, P.D., P. Aich, A. Manuja, K. Hokamp, F.M. Roche, F.S.L. Brinkman, A. Potter, L.A. Babiuk, and P.J. Griebel. 2005. Effect of stress on viral-bacterial synergy in bovine respiratory disease: novel mechanisms to regulate inflammation. Comp Funct Genom. 6:244-250.

Holland, B.P., L.O. Burciaga-Robles, D.L. VanOverbeke, J.N. Shook, D.L. Step, C.J. Richards, and C.R. Krehbiel. 2010. Effect of bovine respiratory disease during preconditioning on subsequent feedlot performance, carcass characteristics and beef attributes. J. Anim. Sci. 88:2486-2499.

Holland, B.P., D.L. Step, J.O. Burciaga-Robles, R.W. Fulton, A.W. Confer, T.K. Rose, L.E. Laidig, C.J. Richards, and C.R. Krehbiel. 2011. Effectiveness of sorting calves with high risk of developing bovine respiratory disease on the basis of serum haptoglobin concentration at the time of arrival at a feedlot. Am. J. Vet. Res. 72:1349-1360.

Kannan, G. T.H. Terrill, B. Kouakou, O.S. Gazal, S. Gelaye, E.A. Amoah, and S. Samake. 2002. Simulated preslaughter holding and isolation effects on stress responses and live weight shrinkage in meat goats. J. Anim. Sci. 80:1771.

Lefcourt, A.M., and T.H. Elsasser. 1995. Adrenal responses of Angus x Hereford cattle to the stress of weaning. J. Anim. Sci. 73:2669-2676.

Lynch, E.M., B. Earley, M. McGee, S. Doyle. 2010. Effect of abrupt weaning at housing on leukocyte distribution, functional activity of neutrophils, and acute phase protein response of beef calves. BMC Vet. Res. 6:39.

Nicol, A.M. 1977. Beef cattle weaning methods. N. Z. J. Agric. 134:17-18.

Macartney, J.E., K.F. Bateman, and C.S. Ribble. 2003. Health performance of feeder calves sold at conventional auctions versus special auctions of vaccinated or conditioned calves in Onatario. J. Am. Vet. Med. Assoc. 223:677-683.

Murata, H., N. Shimada, M. Yoshioka. 2004. Current research on acute phase proteins in veterinary diagnosis: an overview. The Vet Journal. 168:28-40.

Parish, J.A., T. Smith, and R.C. Vann. 2012. Mississippi farm to feedlot program 13-year summary: Effects of steer age and morbidity on feedlot performance and carcass traits. Prof. Anim. Sci. 28: 158-165.

Peterson, E.B., D.R. Strohbehn, G.W. Ladd, and R.L. Willham. 1989. Effects of preconditioning on performance of beef calves before and after entering the feedlot. J. Anim. Sci. 67:1678-1686.

Price, E.O., J.E. Harris, R.E. Borgwardt, M.L. Sween, and J.M. Connor. 2003. Fenceline contact of beef calves with their dams at weaning reduces the negative effects of separation on behavior and growth rate. J. Anim. Sci. 81:116-121.

Reinhardt, C.D., M.L. Hands, T.T. Martson, J.W. Waggoner, and L.R. Corah. 2012. Relationships between feedlot health, average daily gain, and carcass traits of Angus steers. Prof. Anim. Sci. 28:11-19.

Richeson, J.T., E.B. Kegley, J.G. Powell, P.A. Beck, B.L. Vander Ley, and J.F. Ridpath. 2012. Weaning management of newly received beef calves with or without continuous exposure to a persistently infected bovine viral diarrhea virus pen mate: Effects on health, performance, bovine viral diarrhea virus titers, and peripheral blood leukocytes. J. Anim. Sci. 90: 1972-1985.

Roeber, D.L., N.C. Speer, J.G. Gentry, J.D. Tatum, C.D. Smith, J.C. Whittier, G.F. Jones, K.E. Belk, and G.C. Smith. 2001. Feeder cattle health management: Effects on morbidity rates, feedlot performance, carcass characteristics, and beef palatability. Prof. Anim. Sci. 17:39-44.

Roeber, D.L. and W.J. Umberger. 2002. The Value of preconditioning programs in beef production systems. Paper presented at the 2002 Western Agricultural Economics Association Annual Meetings, Long Beach, CA.

St. Louis, D.G., T.J. Engelken, R.D. Little, and N.C. Edwards. 2003. Case Study: Systems to reduce the cost of preconditioning calves. Prof. Anim. Sci. 19:357-361.

Step, D.L., C.R. Krehbiel, H.A. DePra, J.J. Cranston, R.W. Fulton, J.G. Kirkpatrick, D.R. Gill, M.E. Payton, M.A. Montelongo, and A.W. Confer. 2008. Effects of commingling beef calves from different sources and weaning protocols during a forty-two-day receiving period on performance and bovine respiratory disease. J. Anim. Sci. 86: 3146-3158.

Stookey, J.M., K.S. Schwartzkoph-Genswein, C.S. Waltz, and J.M. Watts. 1997. Effects of remote and contact weaning on behavior and weight gain of beef calves. J. Anim. Sci. 75(Suppl. 1):83.(Abstr.)

Tarrant, P.V. 1990. Transportation of cattle by road. Appl. Anim. Behav. Sci. 28:153.

Tindall, B. 1983. Preconditioning Programs. Anim. Nutr. Health (Jul.-Aug.):38. California Farmer Publishing Company, San Francisco.

Van Koevering, M.T., D.R. Gill, F.N. Owens, H.G. Dolezal, and C.A. Strasia. 1995. Effect of time on feed on performance of feedlot steers, carcass characteristics and tenderness and composition of longissimus muscles. J. Anim. Sci. 73:21.

Waggoner, J.W., C.P. Mathis, C.A. Loest, J.E. Sawyer, F.T. McCollum, III, and J.P. Banta. 2007. Case Study: Impact of morbidity in finishing beef steers on feedlot average daily gain, carcass characteristics, and carcass value. Prof. Anim. Sci. 23: 174-178.

APPENDIX
LIFE DIAGNOSTICS, INC., BOVINE HAPTOGLOBIN ELISA KIT

This assay uses affinity purified anti-bovine haptoglobin antibodies for solid phase (microtiter wells) immobilization and horseradish peroxidase (HRP) conjugated anti-bovine haptoglobin antibodies for detection.

Assay Procedure

1. Secure the desired number of coated wells in the holder.
2. Dispense 100 µl of standards and diluted samples into wells.
3. Incubate on an orbital micro-plate shaker at 100-150 rpm at room temperature (18-25 ºC) for 45 minutes.
4. Remove the incubation mixture by flicking plate contents into appropriate Bio-waste container.
5. Wash and empty the microtiter wells 5 times with 1x wash solution. This should preferably be performed using a plate washer (400 µl/well). If a plate washer is not available, use a squirt bottle. The entire wash procedure should be performed as quickly as possible.
6. Strike the wells sharply onto absorbent paper or paper towels to remove all residual droplets.
7. Add 100 µl of enzyme conjugate reagent into each well.
8. Incubate on an orbital micro-plate shaker at 100-150 rpm at room temperature (18-25 ºC) for 45 minutes.
9. Wash as detailed in 4 to 6 above.
10. Dispense 100 µl of TMB Reagent into each well.
11. Gently mix on an orbital micro-plate shaker at 100-150 at 100-150 rpm at room temperature (18-25 ºC) for 20 minutes.

12. Stop the reaction by adding 100 µl of Stop Solution to each well.

13. Gently mix. *Important to make sure all the blue color changes to yellow.*

14. Read the optical density at 450 nm with a microtiter plate reader within 15 minutes.

Calculations:

1. Calculate the average absorbance values (A_{450}) for each set of reference standards and samples.
2. Construct a standard curve by plotting the mean absorbance obtained from each reference standard against its concentration in ng/ml on linear graph paper, with absorbance values on the vertical axis or Y-axis and concentrations on the horizontal axis or X-axis.
3. Using the mean absorbance value for each sample, determine the corresponding concentration of haptoglobin in ng/ml from the standard curve.
4. Multiply the derived concentration by the dilution factor to determine the actual concentration of haptoglobin in the serum/plasma sample.
5. PC graphing software may be used for the above steps.
6. If the OD_{450} values of samples fall outside the standard curve when tested at a 2,000 fold dilution, samples should be diluted appropriately and re-tested.

VITA

Jake Anderson was born in 1989, in Louisiana, to Perry and Kim Anderson. He graduated from high school in 2007 and began his studies at Louisiana State University. He received his Bachelor of Science degree in Animal, Dairy, and Poultry Science in May, 2011. He then began graduate studies at the School of Animal Sciences at Louisiana State University, working towards a Master's degree in Animal, Dairy, and Poultry Science. Upon graduation, he will begin a career in the Animal Nutrition industry as a Sales Representative for a feed mill in Louisiana.