1-1-2015

Effect of Crude Protein Levels and Metaphylaxis on Health, Growth, and Performance of Newly Received Stocker Calves and Subsequent Feedlot and Carcass Performance

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By

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A Thesis
Submitted to the Faculty of
Mississippi State University
in Partial Fulfillment of the Requirements
for the Degree of Master of Science
in Agriculture
in the Department of Animal and Dairy Sciences

Mississippi State, Mississippi

May 2015

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Pages in Study: 44

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The objectives of this study were to evaluate the effects of: (1) metaphylactic antibiotic administration (none or Excede on arrival); and (2) receiving diet crude protein levels (17.1 % or 11.9 % CP) on respiratory disease incidence, mortality, and growth performance of beef calves received into a stocker system as well as the influence of stocker treatment on feedlot and carcass performance. For the stocker phase, steers (n = 244) were stratified by BW and randomly assigned to 20 pens. Treatments were randomly assigned in a 2 x 2 factorial study design. At the conclusion of the stocker phase, 76 steers were sent to Tri County Steer Carcass Futurity in Lewis, IA. Metaphylactic treatment reduced the incidence of BRD and increasing CP in the receiving ration to 17.1 % resulted in greater ADG. Health, nutrition, and management during the stocker phase can impact feedlot and carcass performance.

DEDICATION

This thesis is dedicated to my parents Timothy and Renee Braud who made many sacrifices to ensure that my sister and I had every opportunity to reach our potential and instilled in us the values of responsibility, hard-work, and perseverance; and to my sister, Tori, for mentoring me through every step of my academic career. With your guidance, support, and encouragement, I was able to continue my education and obtain this degree and for that I will be forever grateful.

ACKNOWLEDGEMENTS

I would like to first thank Dr. Brandi Karisch for giving me the opportunity to continue my education at Mississippi State University. This would not have been possible without her guidance and support. In addition to guiding me through my academic and research endeavors, I would also like to thank her for giving me countless opportunities to be involved with the beef cattle Extension program. By being involved with Extension, I have gained invaluable experiences that will make the transition into my career as an Extension agent much smoother. I would also like to thank Drs. David Smith and Jane Parish for serving on my graduate committee and providing their expertise and suggestions during my research project and the writing of my thesis. Next, I would like to thank Dr. Suzanne Genova, Daniel Dodson, and Warren Hillhouse for all of their hard work, sacrifices, and the countless hours that they dedicated to ensuring that this project was a success. This truly would not have been possible without each of you. I would like to give a special thanks to my fellow graduate students, the entire ADS department, as well as the staff at the MSU Beef Unit for their help and encouragement throughout my entire graduate career.

To all of my friends and family, THANK YOU for all of your words of encouragement, phone calls, prayers, and support throughout this entire process.

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NOMENCLATURE

ADG	Average Daily Gain
BW	Body Weight
BRD	Bovine Respiratory Disease
BRSV	Bovine Respiratory Syncytial Virus
BVD	Bovine Viral Diarrhea
CP	Crude Protein
DMI	Dry Matter Intake
DP	Dressing Percentage
FT	12^{th}- Rib Fat Thickness
HCW	Hot Carcass Weight
IBR	Infectious Bovine Rhinotracheitis
KPH	Kidney, Pelvic, and Heart Fat
LM	*Longissimus dorsi* muscle area
NRC	National Research Council
NEg	Net Energy for Gain
NEm	Net Energy for Maintenance
PI	Persistently Infected
PI3	Bovine Parainfluenza Virus Type 3
QG	Quality Grade

USDA	United States Department of Agriculture
YG	Yield Grade

CHAPTER I

INTRODUCTION

Stocker cattle systems add value to recently weaned calves by marketing large lots of uniform-sized calves to cattle feeders. Calves that have been through a stocker system have received various health procedures (e.g., vaccinations, deworming, castration, dehorning) and are better prepared to thrive in confined feeding systems after overcoming the stresses associated with weaning and commingling. However, calves transitioning from a pasture-based ranch system into a beef stocker system can experience unique and multiple stressors that increase the likelihood of bovine respiratory disease (BRD), and stocker cattle growers undertake considerable risk of BRD in the calves that they receive. Bovine respiratory disease is the most common and economically detrimental disease of beef cattle post-weaning, causing approximately 75 % of morbidity and over 50 % of mortality in feedlots (Edwards, 1996; Smith, 1998).

As with other Southeastern cattle, stockers raised in Mississippi are often penalized by buyers based on a poor reputation for health and performance. However, studies have shown that cattle from the Southeast perform well compared to cattle from other regions. A study conducted in Iowa found that calves of Southeastern origin, including calves from Mississippi, had decreased rates of morbidity, decreased treatment costs, and fewer deaths compared to calves of Midwest origin (Busby et al., 2008). However, past surveys have shown that Mississippi beef cattle producers are not consistent in the use of technologies such as vaccination (Little et al., 2000; Mississippi Beef Cattle Improvement Association, 2012). This suggests that there is confusion, or lack of agreement, about the usefulness of products and procedures that are available to aid in improving cattle health and productivity.

Controlling BRD in stocker systems by using a metaphylaxis program is an important management option for producers to consider with newly received cattle. Metaphylactic programs involve administering an approved antimicrobial to a population of cattle that are at risk of developing BRD with the goal of improving the overall health and performance of that population of cattle (Nickell and White, 2010). Several antibiotics have proven to be effective in metaphylactic programs (Duff and Galyean, 2007). However, available data supporting the metaphylactic treatment of stocker calves at receiving are largely empirical. Although BRD rates have been shown to decrease with the use of a metaphylaxis program, it is not a panacea. The cost of metaphylaxis may be greater than the cost of treating sick calves individually, except in groups of calves with high morbidity.

Protein requirements based on the NRC (2000) system are largely a function of body weight (BW) and feed intake. Previous investigations on the influence of dietary crude protein (CP) levels on BRD morbidity have shown conflicting results. Galyean et al. (1999) combined the results from 15 trials from Galyean et al. (1993) and Fluharty and Loerch (1995) to investigate BRD morbidity and receiving diet CP level. Although morbidity increased with increasing CP concentration, performance was equal to or superior to calves fed lower CP levels (Galyean et al., 1999). Whitney et al. (2006) found that early-weaned steers fed a higher level of soybean meal had an increased febrile response when challenged with an intra-nasal dose of bovine herpes virus-1. These results provide evidence for the need for further investigation on the influence of dietary CP on overall health and performance of stocker cattle.

There are several inconsistences in current literature regarding the effects of BRD on feedlot and carcass performance. Gardner et al. (1999) observed a reduction in ADG, final BW, and hot carcass weight (HCW) in steers treated for BRD compared to those that were not treated. Roeber et al. (2001) found that ADG in morbid animals was similar to or greater than ADG of healthy animals whereas Thompson et al. (2006) found that ADG of morbid animals was less than that of healthy animals. Several researchers have reported little to no differences in carcass characteristics for healthy versus morbid animals (Waggoner et al., 2007; Holland et al., 2010). However, Reinhardt et al. (2009) reported that BRD morbidity was negatively correlated with yield grade (YG), HCW, and marbling score, such that morbid animals had increased YG, decreased HCW, and decreased marbling scores.

Average daily gain during the stocker phase is important to profitability. Hersom et al. (2004) found that increasing ADG during the stocker phase led to increased fat on the carcass but did not impact ADG during the finishing phase. Neel et al. (2007) reported that calves with low ADG during the stocker phase had better ADG during finishing. Even with the expression of compensatory gain, they noted that steers were not able to make up what was lost during the stocker phase. In addition, calves with high ADG during the stocker phase had high ADG during the finishing phase and had increased HCW and better USDA quality grades (QG).

CHAPTER II

LITERATURE REVIEW

Introduction

Calves that are received into stocker systems are often naïve and are exposed to a variety of new pathogens. To compound these problems, feed intake is typically low (Cole, 1996), and cattle may not consume enough to meet their net energy requirements for maintenance (NEm) until several days after arrival (Loyd et al., 2011). Average daily gain during this time is usually low due to the reduction in intake. The combination of stress and reduced intake may lead to an increased risk of contracting BRD.

Previous investigations of the influence of dietary CP level on BRD morbidity have shown conflicting results. Galyean et al. (1999) pooled the results from 15 trials from Galyean et al. (1993) and Fluharty and Loerch (1995). They reported that although morbidity increased with CP concentration, performance was equal to or superior to calves fed lower protein levels. The amount of protein required by stocker calves according to the NRC (2000) system is related to BW and dry matter intake (DMI). Fluharty and Loerch (1995) conducted three trials to assess CP needs of lightweight newly received cattle. They determined that increased protein concentrations early in the receiving period, when DMI is typically lowest, resulted in increased gains and feed efficiency.

Previous management can play a role in affecting the performance of cattle later down the production cycle. Some beef producers are often only concerned with performance and profitably in their own phase and fail to understand or care that the management decisions that they are making can affect subsequent performance. As the beef industry progresses, producers need to take into consideration that all beef producers are in the business to produce beef.

There are several health, nutritional, and management options that must be considered when receiving stocker calves to aid in mitigating the adverse effects associated with BRD. Therefore, the objectives of this literature review are to (1) discuss the impact of BRD; (2) review the effect of metaphylactic antibiotic administration on BRD; (3) review the effect of respiratory disease on overall animal performance; and (4) discuss the influence of the stocker phase on subsequent animal performance.

Animal Health and Immunity

The term health can be referred to as the overall welfare and condition of an animal (Galyean et al., 1999). Animal health is usually a subjective matter and determined by visual observation in addition to various clinical measurements. Immunity is a term that refers to the body's reaction to foreign substances that are not associated with a physiological or pathological result of the reaction (Abbas et al., 1991). Galyean et al. (1999) stated that animal immunity is divided into two categories innate (natural) or acquired (specific), and the type of immunity at the time of pathogen exposure can impact the occurrence of BRD. Innate immunity can be described as immunity that is present prior to birth and does not require vaccination to obtain (Abbas et al., 1991).

Acquired immunity can be defined as the immunity acquired from vaccination, or infection, or a passive transfer of antibodies (Ellis et al., 2007).

Bovine Respiratory Disease

Bovine respiratory disease is the most common and economically detrimental disease of beef cattle post-weaning (Edwards, 1996). Economic losses as a result of BRD morbidity and mortality in newly received cattle continue to persist in the beef industry (Galyean et al., 1999) despite improvements in management, vaccines, and antibiotics (Loneragan et al., 2001). Losses related to BRD have been reported to cost the beef industry over $750 million on an annual basis (Griffin, 1997). Costs associated with BRD can be both direct and indirect. Direct costs include health treatments as well as animal losses. Indirect costs include the losses in overall performance of morbid animals compared to their healthy counterparts.

The term BRD can refer to a wide range of pneumonic illnesses, from acute fatal respiratory disease to chronic intractable respiratory disease (Booker et al., 2008). Bovine respiratory disease is a complex of diseases characterized by many types of infection. Each type of infection has its own causes, clinical signs, and economic implications (Snowder et al., 2006). The BRD complex is a multi-factorial disease that is influenced by host and environmental factors, pathogens, and management practices (Nickell and White, 2010). The pathogens that are most common with cases of BRD are a result of both viral and bacterial factors. The major viral pathogens associated with BRD include infectious bovine rhinotracheitis (IBR), bovine viral diarrhea (BVD), bovine parainfluenza virus type 3 (PI3), and bovine respiratory syncytial virus (BRSV) (Callan and Garry, 2002). These viruses predispose the lungs to bacterial infections by suppressing the defense mechanisms of the respiratory tract (Callan and Garry, 2002). The major bacterial pathogens associated with BRD include *Mannheimia haemolytica, Pasteurella multocida,* and *Histophilus somni* (Apley, 2006). The role of *Mycoplasma bovis* as a primary cause of BRD is still being debated (Apley, 2006). *Mannheimia haemolytica* serotype 1 is the organism that is most commonly associated with cases of BRD (Pandher et al., 1998).

Recently, researchers have been focusing on BVD and the impact that this viral agent has on BRD. Bovine viral diarrhea can be transmitted via vertical or horizontal transmission. Vertical transmission occurs in utero as a fetal infection and horizontal transmission occurs during the postnatal period (Thurmond, 2005). Calves can become persistently infected (PI) with BVD when an infection involving a nonpathogenic strain occurs during d 42 to 125 of gestation (McClurkin et al., 1984). These infections remain throughout an animal's life, and PI calves constantly shed the virus making this a very important mode of transmission. Infection often occurs in combination with other infections associated with BRD (PI3 and BRSV; Fulton et al., 2000a). Bovine viral diarrhea PI testing of newly received calves is an important management decision that can aid in reducing the incidence of BRD in cattle populations.

Based on previous research, there are not a substantial number of calves that are classified as being PI. However, researchers have noted that the economic consequences associated with PI calves could be significant (Wittum et al., 2001; Fulton et al., 2006). In 2001, Wittum et al. evaluated 18,931 calves in 128 herds for the presence of PI calves. They found that 56 calves out of 13 herds were identified as being PI calves and 61 % of those calves remained positive at 6 months of age. Fulton et al. (2006) found 86 PI calves out of 21,743 animals that were evaluated. Although prevalence is small, these calves pose a significant threat because PI calves are continuously shedding the virus, and infecting other animals in the herd.

Cattle face numerous stressors that greatly influence the risk of BRD (e.g., weaning, transportation, commingling, and processing; Schneider et al., 2009). These stress factors enhance predisposing causes and increase environmental risk factors (Snowder et al., 2006). Predisposing factors are usually synergistic and may include age, stress, and immunological background (Callan and Garry, 2002). Environmental factors include climate, ambient temperature, dust particles, stocking density, humidity, ventilation, and shipping distance (Snowder et al., 2006). Snowder et al. (2006) also noted that castration just prior to feedlot entry may be a predisposing cause of BRD. Proper timing of castration is vital in reducing the amount of stress that cattle face when transitioning into the feedlot phase.

Morbidity and mortality associated with BRD varies greatly in current literature, and these measurements vary with different stages of production. Holland et al. (2010) reported a BRD morbidity rate of 57.6 % and a mortality rate of 8.6 % during a 63-d preconditioning period involving 330 heifers (BW = 241.3 ± 16.6 kg). Once these calves entered the feedlot, BRD morbidity was 1 %. Brazle (1997) conducted 3 trials using 170 lightweight bull calves (134 kg) and observed a morbidity rate of 75.5 % for control calves and 59.7 % for calves that were administered tilmicosin on arrival. Brazle (1997) also reported a mortality rate of 8.1 % for the control group versus 1.2 % for the treated group. Snowder et al. (2006) evaluated 18,112 feedlot calves over a 15-year period and reported that 4 % of calves died due to BRD and the incidence of BRD ranged from 5 to

44 % during the evaluation period. Schneider et al. (2009) conducted a study utilizing 5,976 head of cattle and 8.17 % of the animals were treated for BRD. Mortality associated with BRD was 0.86 %. These differences that have been observed across studies may be due to several reasons, including the definition of BRD used in the experiment, treatment protocols, as well as the stage of production.

In 2001, Roeber et al. conducted a study to evaluate the effects of BRD morbidity on feedlot performance, carcass characteristics, and beef palatability traits. This study utilized three groups of feeder steers purchased from two value-added programs and a traditional auction market. Morbidity and mortality rates were approximately 41.6 % and 10.3 % more for cattle acquired from the auction market, respectively. Kelly and Janzen (1986) reported that BRD morbidity and mortality rates usually range from 0 to 69 % and 0 to 15 %, respectively. Roeber et al. (2001) stated that morbidity resulted in economic losses as a result of mortality and increased costs associated with treatment.

Diagnosis of BRD

The definition of BRD varies greatly in current literature although clinical signs are consistent across most studies. Typically, newly received calves susceptible to BRD are evaluated using a subjective, visual evaluation and minimal clinical measurements are taken (Galyean et al., 1999). Holland et al. (2010) divided symptoms of BRD into 3 categories. Those categories included signs of depression, signs of abnormal appetite, and respiratory signs. Signs of depression included hanging head, sunken or glazed eyes, and slow movement. Signs of abnormal appetite included cattle that are completely off feed, eating less or with less aggression than penmates, lack of fill, or obvious loss of BW. Respiratory signs included labored breathing, extended head and neck, and noise while breathing. A clinical scoring system (1 to 4) has been developed with level of severity increasing as the number increases (Perino and Apley, 1998).

Elevated body temperature is another sign of illness associated with bovine respiratory disease. One or more signs of BRD are usually present before a rectal temperature is taken. The temperature required for a calf to be diagnosed with BRD varies in current literature. Fluharty and Loerch (1996) used 39.4°C as the minimum temperature to diagnose a calf with BRD whereas Booker (2008) used 40.5°C. Galyean et al. (1999) stated that cattle are considered to have BRD when rectal temperature exceeds 39.7°C and one or more of the visual signs are present. In a more recent study, Holland et al. (2010) pulled cattle showing visual signs of respiratory disease and treated those with a rectal temperature greater than 40.0°C. Perino and Apley (1998) used a rectal temperature greater than or equal to 40.0°C as the temperature required for an animal to require therapeutic treatment. Galyean et al. (1999) stated that the potential for an incorrect diagnosis of BRD is generally high due to the subjective nature of diagnosis.

Previously, Wittum et al. (1996) evaluated BRD morbidity compared to lung lesions observed at slaughter. This was done to determine if current, subjective methods of BRD diagnosis are effective. These researchers determined that only 35 % of steers were treated for BRD and yet, 72 % were observed to have pulmonary lesions at slaughter. Wittum et al. (1996) also indicated that lesions were present on 78 % of treated steers. Similarly, Thompson et al. (2006) reported that 42.8 % of all animals had lung lesions present at slaughter and 69.5 % of those animals were never treated for BRD. These results indicate that evaluation of lung lesions at slaughter may be useful to determine the effectiveness of BRD diagnosis and treatment protocols. Quantifiable methods for identifying BRD may be needed to become more accurate with diagnosis.

Metaphylaxis

There are several health, nutritional, and management options available to aid in controlling BRD in beef cattle production systems. Depending on the severity of the disease, multiple therapeutic methods may be required to improve the health status of the animal. Metaphylactic antimicrobial administration at arrival is a management practice that is commonly used to reduce the bacterial pathogen load seen in cattle populations (Nickell and White, 2010).

Metaphylaxis involves administering an approved antimicrobial, before clinical signs are present, to a population of cattle that are at risk of developing BRD with the goal of improving the overall health and performance of that population of cattle (Nickell and White, 2010; Ellis et al., 2007). Administering medication to a group of highly-stressed, newly-received calves can be used as an effective way to decrease the incidence of BRD (Galyean et al., 1995) as well as improve ADG and overall performance of cattle (Wileman et al., 2009). Extensive research involving the effect of metaphylaxis has been conducted for many years. Several different antimicrobials have been researched as an effective drug to use in metaphylaxis protocols.

During the 1980's, Lofgreen reported the advantages of mass treating highly-stressed calves at arrival to the feedlot. Lofgreen (1980) reported that the administration of oxytetracycline at arrival decreased death loss and the number of calves that required subsequent treatment. In a different study, Lofgreen (1983) found that the use of oxytetracycline and sustained-release sulfadimethoxine reduced morbidity from 63.3 %

in untreated calves to 7.1 % in calves treated upon arrival. Van Donkersgoed (1992) performed a meta-analysis on numerous trials to determine the efficacy of mass medication in feedlot cattle and results showed that administering a long-acting oxytetracycline would reduce the risk of BRD. Wileman et al. (2009) also performed a meta-analysis comparing the performance of cattle that were administered metaphylactic treatment on arrival with cattle that did not receive metaphylactic treatment. Results showed that those treated on arrival gained 0.11 kg/d more than those that did not receive antimicrobial treatment.

Several studies have been conducted to observe the effects of using tilmicosin phosphate (Micotil®) on arrival to control BRD. Galyean et al. (1995) and Brazle (1997) both found that metaphylactically administering Micotil® reduced morbidity and mortality rates and improved ADG. Brazle (1997) found that metaphylaxis reduced morbidity by 15.8 % and reduced mortality by 6.9 % in 170 lightweight (134 kg) calves. In addition, ADG was increased by 0.03 kg/d for treated calves compared to the control group. Galyean et al. (1995) conducted 3 different trials and reported that metaphylaxis did not significantly affect ADG in trials 1 and 2, but ADG was increased in calves treated at arrival compared to the control group during trial 3. The authors noted that the increase in ADG was likely due to the positive effects of the metaphylactic program on gain. Calves that do not contract BRD would be expected to gain more rapidly than morbid calves (Bateman et al., 1990; Morck et al., 1993; McCoy et al., 1994; Wittum et al., 1994).

Metaphylaxis has been shown to reduce morbidity and increase performance in newly received cattle, but it will not eliminate BRD in cattle populations (Nickell and

White, 2010). The cost of administering medication to the entire population of cattle may be greater than the cost to treat sick calves individually. In cases of high morbidity, the cost of metaphylaxis may be less than treating sick calves individually. Producers may want to consider using metaphylaxis as a management option to reduce the number of health problems and the labor required with newly received calves (Brazle, 1997). The effectiveness of a metaphylaxis program in decreasing BRD does not eliminate the need for sound husbandry and management practices (Galyean et al., 1995).

Impact of dietary CP level on BRD

Newly-received calves face numerous obstacles that can increase the risk of respiratory complications. These calves are usually lightweight and experience stress from weaning, transportation, and commingling, and all of these stress factors can have negative impacts on the immune system (Sweiger, 2010). In addition, calves are usually naïve, exposed to a variety of new pathogens, and usually face periods of decreased intake (Cole, 1996). Feed intake of newly-received cattle is often low during the first 2 wk after receiving (Fluharty and Loerch, 1995). Cole and Hutcheson (1990) reported that maximum DMI after receiving could only be met when the receiving diet was higher in CP than the diet that the cattle were previously consuming. Since DMI is low during the initial weeks after receiving, increased CP concentrations could be required to offset the effects of low DMI (Fluharty and Loerch, 1995). The combination of stress and reduced intake could possibly increase susceptibility to infection.

Protein requirements based on the NRC (2000) system are largely a function of BW and DMI. Galyean (1999) reported that newly-received calves often have a low net energy intake, and they are likely to have a low capacity for protein deposition. Calves that experience less of a decrease in DMI would likely have greater CP needs. Thus, the amount of protein required by newly received calves during the first couple days after arrival is heavily influenced by the amount of feed that is consumed (Galyean et al., 1999). Fluharty and Loerch (1995) determined that increased protein concentrations early in the receiving period, when DMI is typically least, resulted in increased gains and feed efficiency.

Previous investigations of the influence of dietary CP level on BRD morbidity have showing conflicting results. Galyean et al. (1999) pooled the results from 15 trials from Galyean et al. (1993) and Fluharty and Loerch (1995) to investigate BRD morbidity and receiving diet CP level. Galyean et al. (1999) found that morbidity increased with increasing CP concentration and that performance was equal to or superior to calves fed lower protein levels. Cole and Hutcheson (1990) found that for stressed, lightweight calves that were fed diets that contained 12 % or 16 % CP, DMI and ADG were increased with the 16 % CP diet in one trial, but not in another. BRD morbidity was high in both trials and was not affected by protein level. Whitney et al. (2006) found that steers that were weaned early and fed an increased level of soybean meal (47.7 % CP) experienced an increase in ADG and DMI during an 84-d backgrounding period. In addition, steers that were fed increased protein diets had an increased febrile response when challenged with an intra-nasal dose of BHV-1. The combination of these results leads to the question if calves fed greater levels of CP may be inaccurately diagnosed with BRD, and if the increase in performance is able to offset increased treatment costs.

Effect of BRD on growth and performance

Average daily gain is a measurement used to evaluate the growth performance of cattle on feed and can be defined as the total BW gained during the feeding period divided by the number of days on feed (Ellis et al., 2007). Bovine respiratory disease has been shown to have a significant effect on ADG. Several authors have noted a significant decrease in ADG of animals that have been treated for BRD compared to healthy animals. Bateman et al. (1990) saw a difference in ADG of 0.06 kg between healthy calves and those treated for BRD. Similarly, Snowder et al. (2006) observed a 0.04 kg difference in ADG and Schneider et al. (2009) observed a 0.07 kg difference in ADG for healthy calves compared to calves that were treated for BRD. Thompson et al. (2006) observed a smaller difference in ADG and reported that healthy calves gained 0.02 kg more per day than calves diagnosed with BRD. These results are similar to those of Jim et al. (1993) who observed no difference in ADG. Snowder et al. (2007) reported that no difference was seen in ADG for cattle treated for BRD compared to healthy cattle. The reason for the differences in ADG among studies may be due to several different factors. Some of those factors could include definition of BRD, accuracy of clinical diagnosis of BRD, and the severity of the disease (Thompson et al., 2006).

Bovine respiratory disease has been shown to have an affect on United States Department of Agriculture (USDA) QG and YG. Quality grade is based on the palatability of the meat product, while YG is based on the amount of product that is produced from the carcass. Quality grade is determined from marbling and maturity data, while YG is determined from HCW, *Longissimus dorsi* muscle area (LM), 12th-rib fat (FT) and kidney, pelvic, and heart fat (KPH) (Holland et al., 2010).

Snowder et al. (2007) found that calves treated for BRD did not differ from their healthy counterparts for marbling score, percentage of fat in the rib soft tissue and LM, and LM palatability traits. Holland et al. (2010) observed no differences in HCW, FT, LM area, internal fat, or YG; however, they did observe a linear trend of decreasing marbling score as the number of BRD treatments increased. Schneider et al. (2009) observed a significant difference in HCW, subcutaneous fat cover, and marbling score and reported that cattle not treated for BRD during the study had more desirable estimates for all carcass traits when compared to cattle that were treated. Reinhardt et al. (2009) noted that BRD morbidity was negatively correlated with YG, HCW, and marbling score.

In some cases, researchers have indicated that more pronounced negative effects on growth and carcass performance are seen as the number of BRD treatments increase. Gardner et al. (1999) reported that steers treated for BRD one time gained weight faster, had more external and internal fat, had a greater dressing percent (DP), increased carcass weights, and a greater numerical YG than calves treated multiple times for BRD. These researchers also noted that there was no difference in LM area or palatability measures for steers treated once or more than once for BRD. Gardner et al. (1999) reported that animals treated multiple times produced significantly more Standard carcasses than animals that were treated 2 times or less.

Another group of researchers (Roeber et al., 2001) reported that no difference was seen in carcass traits between cattle that were never treated or treated one time for BRD. However, calves treated two or more times for BRD had lower HCW, marbling score, DP, and YG compared to their counterparts (Roeber et al., 2001). Bovine respiratory disease has been shown to influence several different growth and carcass parameters.

Based on current literature, the effects of BRD on growth and carcass performance is variable and this topic warrants further investigation.

Effect of stocker phase on feedlot and carcass performance

The stocker phase of the beef industry plays a vital role in preparing calves for confined feeding systems. Most stocker producers ensure that cattle have been weaned for a certain amount of time, vaccinated, dewormed, castrated, dehorned, and accustomed to feed bunks and water troughs. By allowing calves the time needed to overcome the stresses associated with theses processes, the transition into the feedlot phase becomes less stressful.

The goal of most stocker cattle producers is to add value to calves while optimizing performance and profitability. Some producers are only concerned with profitability in their respective segment and neglect to consider the ramifications of their management decisions and how they can affect the animal later down the production cycle. Feeder cattle buyers are also looking to maximize their net returns and they may discount cattle that have been managed in a way that will affect future performance. As the beef industry progresses, it is important for producers to consider all aspects of the production cycle and how their decisions will impact the final end product, beef.

Average daily gain during the stocker phase is important to profitability. There has been a significant amount of research done on whether ADG during the stocker phase should be high or low and the effects of ADG on future performance. Hersom et al. (2004) found that increasing ADG during the stocker phase led to increased fat on the carcass, but did not impact ADG during the finishing phase. Neel et al. (2007) found that calves with low ADG during the stocker phase had better ADG during finishing. Even with the expression of compensatory gain, they noted that steers were not able to make up what was lost during the stocker phase. In addition, calves with high ADG during the stocker phase had increased carcass weights and better USDA QG (Neel et al., 2007). The amount of weight that cattle gain during the stocker phase has been shown to have an effect on subsequent feedlot and carcass performance, however other factors such as cost of gain must be considered when determining the level of gains to target.

The occurrence of BRD prior to the feedlot phase has also been shown to affect finishing and carcass performance. Holland et al. (2010) observed a difference in BW at the conclusion of the preconditioning period, with cattle never treated for BRD weighing heavier than cattle treated for BRD. The researchers also observed a significant difference in ADG throughout the preconditioning and finishing phases, with healthy cattle having 59 % and 8.7 % greater ADG than cattle treated 3 times in the preconditioning and finishing phases, respectively. After the preconditioning phase, Holland et al. (2010) observed a period of compensatory gain from morbid animals, which is likely the reason that no difference was seen in finishing ADG across BRD treatment groups. Similar results were observed by Thompson et al. (2006), Montgomery et al. (2009), and Schneider et al. (2009), who observed a decrease in ADG during the receiving phase for morbid animals but no difference in finishing ADG across treatment groups due to the expression of compensatory gain following the receiving phase.

In terms of carcass performance, Holland et al. (2010) observed no differences in HCW, FT, LM area, internal fat, or YG. However, they did see a linear trend of decreasing marbling score as the number of BRD treatments increased. Similarly, Schneider et al. (2009) observed that 16 % more nontreated animals graded Choice than did animals from BRD treatment groups.

Even with the expression of compensatory gain for morbid cattle, marbling and QG will likely be decreased when compared to healthy animals. Cattle requiring multiple treatments for BRD seem to have the potential to produce carcasses with similar value, except in terms of marbling score, to their healthy counterparts. As the number of BRD treatments increase, additional days on feed may be required for cattle to reach this common endpoint and produce carcasses with similar value (Holland et al., 2010).

Conclusion

Bovine respiratory disease has been recognized as a problem in the beef industry for many years. Despite the advancements in management practices, vaccines, and antibiotics, BRD continues to cost the beef industry a significant amount of money each year (Griffin, 1997; Loneragan et al., 2001). The costs associated with BRD are not only influenced by treatment costs and mortality, but also indirect costs associated with decreased performance in calves diagnosed with BRD. Bovine respiratory disease is caused by many different factors, and each case has its own clinical signs (Snowder et al., 2006).

Metaphylaxis, or mass medication at arrival, is an important management option for newly received cattle and has been studied extensively. Several different types of antimicrobials have proven to be effective in reducing the incidence of BRD and improving the overall performance of beef cattle (Lofgreen, 1983; Van Donkersgoed, 1992; Wileman, 2009; Brazle, 1997; Galyean et al., 1995). Galyean et al. (1995) stressed that the use of a metaphylaxis program cannot replace the need for good management practices.

Newly received cattle are usually lightweight, have a suppressed immune system, and are susceptible to infection from exposure to a variety of new pathogens during weaning, transportation, and commingling. In addition, feed intake is generally low. The incidence of BRD is generally high during the receiving period due to these and other stress factors. Bovine respiratory disease has been shown to have a significant influence on the overall performance of cattle. Several researchers have reported that BRD causes a decrease in ADG, carcass characteristics, and several other performance measurements.

Health and management during the stocker phase can impact subsequent performance. Management decisions are ultimately focused on the bottom line of each operation. Potential impacts further down the production cycle should be factored into management decisions to aid in improving the overall health and performance of cattle through all phases of the beef industry.

CHAPTER III

EFFECT OF CRUDE PROTEIN LEVELS AND METAPHYLAXIS ON HEALTH, GROWTH, AND PERFORMANCE OF NEWLY RECEIVED STOCKER CALVES

Objectives

The objectives of this study were to evaluate the effects of: (1) metaphylactic antibiotic administration (none or Excede® on arrival); and (2) receiving diet crude protein levels (17.1 % or 11.9 % CP DM) on respiratory disease incidence, mortality, and growth performance of beef calves received into a stocker system.

Materials and Methods

All procedures in this study were approved by the Institutional Animal Care and Use Committee of Mississippi State University (IACUC # 13-070).

Animals and Management

This study was a 2 x 2 factorial design with 2 levels of metaphylaxis (none or ceftiofur crystalline free acid, Excede®, Zoetis, Florham Park, NJ) on arrival and 2 levels of dietary crude protein (17.1 % or 11.9 % CP DM; Diet 1 and Diet 2, respectively). Crossbred steer calves (n=244; initial BW = 220.9 ± 16.9 kg), purchased through an order buyer, were stratified by weight and randomly assigned to 20 pens with treatment being randomly assigned to each pen. Steers were of southeastern origin and acquired from

Mississippi, Alabama, Tennessee, and Georgia. The cattle used in this study were made up of various different breeds and breed types (65 % black, 10 % red, 14 % smoke, 1 % white, 10 % yellow, 12 % white faced, 4 % brockle faced). Steers were housed at the Mississippi Agricultural and Forestry Experiment Station H.H. Leveck Animal Research Center located in Mississippi State, MS. The 60-day receiving trial lasted from September 6, 2013 to November 5, 2013.

Upon arrival at Prairie Livestock, LLC in West Point, MS, the steers were individually identified and vaccinated for infectious bovine rhinotracheitis (IBR), bovine viral diarrhea (BVD), parainfluenza virus type 3 (PI3), and bovine respiratory syncytial virus (BRSV) using a modified-live vaccine (Vista 5, Merck Animal Health, Whitehouse Station, NJ). Upon arrival at the Leveck Animal Research Center, calves were weighed, treated, and ear-notched for persistent BVD infection (PI) testing. Ear notch samples were sent to the Mississippi State University Veterinary Research and Diagnostic Laboratory for analysis. Three steers tested positive and were classified as being PI with BVD. Calves were weighed on arrival and every 14 days through day 55 of the 60-day trial.

Cattle were examined daily on horseback by a trained observer at 0700 for visual signs of BRD (e.g., nasal discharge, ocular discharge, lethargy, inappetence, coughing, labored breathing). Calves that showed visual signs of BRD were pulled for further examination and rectal temperature was taken. Cattle receiving metaphylactic treatment were not treated for BRD during the first 7 days (post-treatment interval). However, cattle diagnosed with BRD were recorded. Bovine respiratory disease was diagnosed at the first clinical sign and body temperature greater than 40°C. Pen riders were blinded to treatment during the post treatment interval, and BRD was diagnosed and treated by a licensed veterinarian during that time. The BRD treatment protocol involved administering Florfenicol (Nuflor, Merck Animal Health, Whitehouse Station, NJ) as the initial treatment and Noromycin (LA 300, Norbrook®, Lenexa, KS) as the second treatment. Further treatment involved the following antibiotics and was at the discretion of the attending veterinarian: Tilmicosin phosphate (Micotil®, Elanco Animal Health, Greenfield, IN), ceftiofur crystalline free acid (Excede®, Zoetis, Florham Park, NJ), Tulathromycin (Draxxin, Zoetis, Florham Parkm NJ), and Enrofloxacin (Baytril®, Bayer DVM, Shawnee Mission, KS). Once an animal was determined to be moribund a licensed veterinarian euthanized the animal. All of the animals that died were sent to the Mississippi State University Veterinary Research and Diagnostic Laboratory, Mississippi State, MS and a necropsy was performed to determine the cause of mortality.

Morbidity was measured as incidence density. Incidence density was calculated as: number of new BRD cases divided by calf days at risk. Days at risk were defined as the number of days from arrival until a calf: 1) was first diagnosed with BRD; 2) died; or 3) finished the trial.

Cattle were fed once daily (NEg = 0.79 mcal/kg) at 2.0 % of BW of the pen. Diet composition is presented in Table 3.1. Experimental diets were obtained from Neshoba County Gin (Philadelphia, MS). Except for the difference in CP, diets were isoenergetic and formulated to meet nutrient requirements based on NRC recommendations. Feeding levels were recalculated after each weigh day to ensure that each pen was being fed 2.0 % of the average BW of the pen. A sample was collected from each new batch of feed and the samples were composited and sent to Cumberland Valley Analytical Services in Maugansville, MD for nutritional analysis.

Statistical Analysis

All data were analyzed using SAS software version 9.3 (SAS Institute Inc., Cary, NC). The effects of metaphylaxis and diet on BRD incidence density were tested by Poisson regression in a generalized linear mixed model (PROC GLIMMIX). The effects of metaphylaxis, diet, and incoming BW on mortality from all causes were tested in a log-binomial model (PROC GLIMMIX). The effects of metaphylaxis and diet on ADG were tested in a generalized estimating equations model (PROC GENMOD). All models accounted for clustering by pen and significance was defined at $P \leq 0.05$ with trends being defined at $P \leq 0.10$.

Results and Discussion

There was no interaction between metaphylaxis and diet ($P > 0.10$), and as such all results are presented separately.

Performance Results

Results for growth and ADG are displayed in Table 3.2. As anticipated, no difference was seen in initial BW across all treatments ($P = 0.84$). Final BW differed ($P = 0.0008$) in regards to diet. Cattle that were fed Diet 1 gained an additional 9.2 kg over the 60-d trial. Accounting for metaphylaxis, cattle that received Diet 1 gained an additional 0.19 kg/d ($P = 0.0008$). This is similar to results observed by Cole and Hutcheson (1990) and Whitney et al. (2006) who observed that cattle fed diets with greater CP levels had greater ADG compared to their counterparts that were fed diets with lesser CP levels.

Galyean et al. (1993) observed that ADG increased linearly as the CP in the ration concentration increased ($P < 0.05$). In addition, during 1 of 3 trials Fluharty and Loerch (1995) reported that ADG increased linearly as the CP concentration increased during the first week of the trial.

Steers receiving metaphylaxis tended to have increased ADG ($P = 0.10$) and final BW ($P = 0.10$). This is in agreement with the findings of Wileman et al. (2009) who found that cattle that received metaphylactic treatment gained an additional 0.11 kg/d compared to cattle that did not receive metaphylactic treatment. Previous research has noted that an increase in animal performance as a result of a metaphylaxis program is likely due to decreased morbidity. Animals that do not succumb to respiratory disease would be expected to gain more rapidly than morbid animals (Bateman et al., 1990; Morck et al., 1993; McCoy et al., 1994; Wittum et al., 1994). Overall, for the 212 cattle finishing the trial, ADG was 0.72 kg/d.

Health Results

During the stocker phase, 181 calves were treated for BRD over 5,994 days at risk, giving a total incidence density of 30.2 cases of BRD per 1000 calf days. BRD morbidity during the trial totaled 74 %, with mortality totaling 13 %. Similarly, Cole and Hutcheson (1990) reported that 42 of 340 calves (12.5 %) died due to causes associated with BRD. Holland et al. (2010) reported a BRD morbidity of 57.6 % and a mortality rate of 8.6 % during a 63-d preconditioning period involving 330 heifers (BW = 241.3 ± 16.6 kg). Snowder et al. (2006) evaluated 18,112 feedlot calves over a 15-year period and reported that 4 % of calves died due to BRD and BRD incidence ranged from 5 % to 44 %. These differences in morbidity and mortality could be due to several different factors including definition of BRD, treatment protocols, as well as the stage of production. The high morbidity and mortality rates in the current study could be due to several different factors. Cattle were acquired from several different locations and commingled upon arrival at the order buyer's facility. This process could have exposed the animals to new pathogens resulting in cases of BRD.

As shown in Figure 3.1, accounting for fixed effects of diet, metaphylaxis, and arrival BW, cattle receiving metaphylaxis were 51 % less likely to be diagnosed with BRD (RR = 0.49, $P = 0.0004$). Morbidity totaled 82 % in steers that did not receive Excede® and 66 % in steers that did receive Excede®. Several studies have shown that the use of injectable antibiotics on a metaphylactic basis has been successful in decreasing the incidence of BRD. Lofgreen et al. (1983) reported that the use of oxytetracycline and sustained-release sulfadimethoxine reduced morbidity from 63.3 % in untreated calves to 7.1 % in calves treated upon arrival. Brazle et al. (1997) observed a difference of 15.8 % in BRD morbidity for calves treated with Micotil® on arrival versus those that did not receive antibiotic on arrival.

For every additional 45.36 kg at arrival the incidence of BRD was reduced by 47 % (RR = 0.54, $P = 0.002$). These results are similar to those reported by Sanderson et al. (2008) who stated that heavier arrival weights were associated with decreased morbidity risk. This group of researchers found that calves weighing more than 318 kg were less likely to be diagnosed with BRD than calves weighing less than 250 kg (RR = 0.18, $P < 0.00$). Similarly, Gummow and Mapham (2000) reported that calves weighing less than the mean BW of the population were 1.4 times more likely to be diagnosed with BRD than those that weighed more than the mean BW of the group. In 2004, Pinchak et al.

evaluated several groups of stocker calves and found that in some groups, there was an association between BW and BRD, with lighter calves having a greater incidence of BRD. The cattle that were lighter at arrival could have been younger than their heavier counterparts. It can be speculated that the lighter cattle could have had less immunity due to the fact that they had not been exposed to potential pathogens and given an opportunity to build up immunity to those pathogens.

Neither diet, nor the interaction between diet and metaphylaxis were significantly associated with BRD incidence (RR = .73, $P = 0.11$); however, BRD incidence was 27 % less for those calves fed Diet 1 (Figure 3.2). Cole and Hutcheson (1990) reported that morbidity was greater than 50 % during 2 trials, and the level of CP in the ration did not affect morbidity in either trial. Galyean et al. (1993) found that as the CP concentration in the ration increased, morbidity associated with BRD increased as well. Fluharty and Loerch (1995) reported similar results during 1 of 3 trials.

Overall, death loss totaled 32 calves. Neither diet, metaphylaxis, nor incoming BW were significantly associated with the risk for mortality. These results are similar to those of Cole and Hutcheson (1990) who reported that receiving diet CP concentrations were not associated with morbidity or mortality. These results do not correspond with the findings of Brazle et al. (1997) who reported that tilmicosin phosphate at arrival reduced mortality by 6.9 % ($P < 0.05$).

Conclusions

Bovine respiratory disease continues to negatively affect the cattle industry and has been shown to cost producers a significant amount of money each year. In this study, there was no interaction between metaphylaxis and diet. As previous research suggested, this study found that metaphylactic antibiotic administration reduced the incidence of BRD. Additionally, increasing the level of CP in the receiving ration to 17.1 % resulted in an increase in ADG and an increase in final BW. Metaphylaxis reduced the incidence of BRD; however, an economic analysis may need to be performed in order to evaluate if the metaphylactic program was economically advantageous.

Table 3.1 Ingredient and nutrient composition of experimental diets[1]

Item	Diet 1	Diet 2
Ingredient, % of DM		
Corn	43.7	47.3
Cottonseed Hulls	17.7	19.2
Salt	0.4	0.4
Soybean Hulls	7.0	19.2
Limestone	1.3	1.2
Molasses	4.1	4.1
Cottonseed Meal	25.7	8.6
Nutrient Composition[2]		
DM, %	87.3	87.5
CP	17.1	11.9
NEm, mcal/kg	1.34	1.39
NEg, mcal/kg	0.77	0.82
ADF	25.3	30.1
NDF	39.2	45.5
CF	2.48	2.61

[1]DM = dry matter, CP = crude protein, NEm = net energy for maintenance, NEg = net energy for growth, ADF = acid detergent fiber, NDF = neutral detergent fiber, CF = crude fat
[2]Nutrient composition determined by Cumberland Valley Analytical Services

Table 3.2 Effect of metaphylaxis and diet on growth and ADG[1,2]

	Treatment					
Item	Diet 1	Diet 2	P-value	Excede®	No Excede®	P-value
Initial BW, kg	221.1 ± 16.5	220.8 ± 17.4	0.84	221.3 ± 17.6	220.6 ± 16.2	0.33
Final BW, kg	265.8 ± 25.2	256.6 ± 30.8	0.0008	263.2 ± 28.4	259.1 ± 28.4	0.10
ADG, kg/d	0.81 ± 0.36	0.62 ± 0.43	0.0008	0.74 ± 0.40	0.69 ± 0.41	0.10

[1]BW = body weight, ADG = average daily gain
[2]Mean ± standard deviation

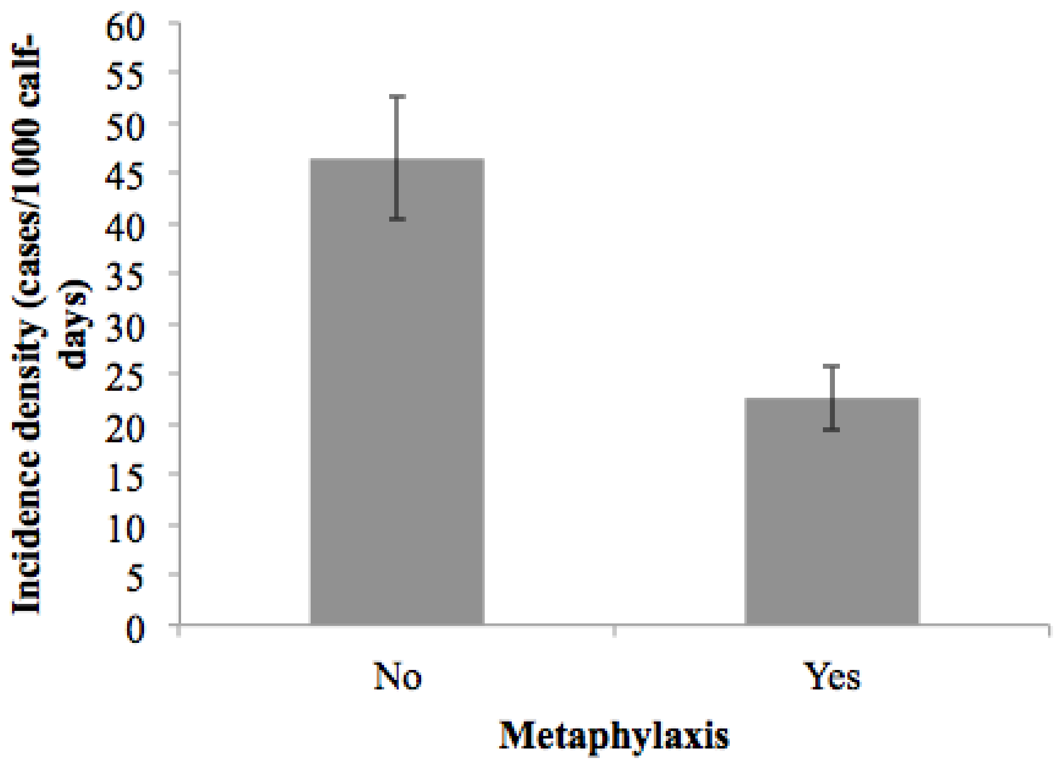

Figure 3.1 Effect of metaphylaxis on bovine respiratory disease incidence density

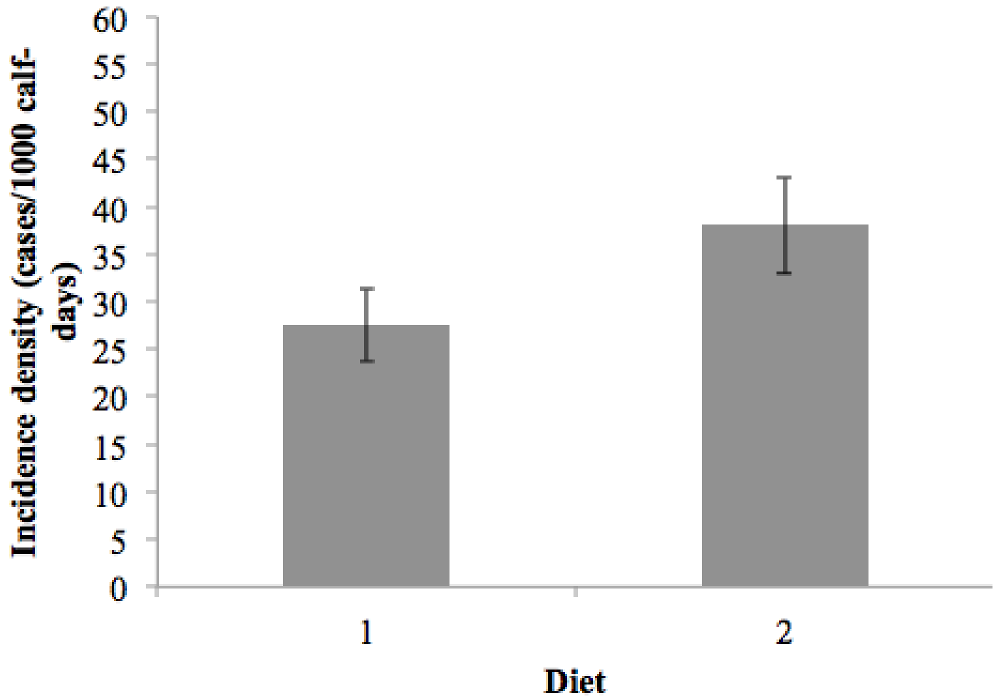

Figure 3.2 Effect of diet on bovine respiratory disease incidence density (Diet 1 = 17.1 % CP, Diet 2 = 11.9 % CP)

CHAPTER IV

EFFECT OF CRUDE PROTEIN LEVELS AND METAPHYLAXIS DURING THE STOCKER RECEIVING PHASE ON FEEDLOT AND CARCASS PERFORMANCE

Objectives

The objectives of this study were to evaluate the effects of: (1) metaphylactic antibiotic administration (none or Excede® on arrival); and (2) receiving diet crude protein levels (17.1 % or 11.9 % CP DM) for calves received into a stocker system on finishing and carcass performance.

Materials and Methods

All procedures in this study were approved by the Institutional Animal Care and Use Committee of Mississippi State University (IACUC # 13-070).

Animals and Management

The stocker phase of this study was a 2 x 2 factorial design with 2 levels of metaphylaxis (none or ceftiofur crystalline free acid, Excede®, Zoetis, Florham Park, NJ) on arrival and 2 levels of dietary CP (17.1 % or 11.9 % CP DM; Diet 1 and Diet 2, respectively). Steer calves (n = 244; initial BW = 220.9 ± 16.9 kg) were acquired through an order buyer and housed at the Mississippi Agricultural and Forestry Experiment Station H.H. Leveck Animal Research Center located in Mississippi State, Mississippi.

Steers were of southeastern origin and made up of various different breeds and breed types (65 % black, 10 % red, 14 % smoke, 1 % white, 10 % yellow, 12 % white faced, 4 % brockle faced). The 60-d stocker receiving trial lasted from September 6, 2013 to November 5, 2013.

Upon completion of the 60-day stocker phase, 76 of the 212 steers that finished the trial were randomly selected and sent to Tri County Steer Carcass Futurity (TCSCF) in Lewis, Iowa. Steers were selected from animals meeting a minimum BW requirement (227 kg) set by TCSCF. The average BW of the 76 calves was 302 ± 16.7 kg, and 19 head from each stocker treatment were selected. On November 21, 2013 the steers (n = 76) were transported by truck approximately 1290 km from Mississippi State, MS to Lewis, IA.

Steers were fed to a target backfat of 1 cm and harvested in 2 groups. The first group of steers (n = 25; Group 1) was harvested on May 6, 2014, and the second group (n = 51; Group 2) was harvested on June 10, 2014. Ractopamine hydrochloride (Optaflexx, Elanco Animal Health, Greenfield, IN) was fed to the second harvest group for 28 days. Lungs were scored gross lesions to indicate active or resolved cases of pneumonia. Tri County Steer Carcass Futurity provided measures of health, growth performance, and carcass quality.

Statistical Analysis

All data were analyzed using SAS software version 9.3 (SAS Institute Inc., Cary, NC). Generalized linear mixed models were used to test continuous outcomes (PROC GLIMMIX). Logistic regression was used to test factors associated with YG and QG

(PROC GLIMMIX). All models accounted for clustering by pen and significance was defined at $P \leq 0.05$ with trends being defined at $P \leq 0.10$.

Results and Discussion

Health Outcomes

Two calves were treated for BRD in the feedlot (2.6 %). Both calves treated for BRD in the feedlot were fed Diet 2 and were administered metaphylactic treatment in the stocker phase. Treatment effects on feedlot morbidity and mortality were not tested because of the low incidence of BRD that was observed in the feedlot. Similarly, Holland et al. (2010) treated 2 heifers for BRD during the finishing phase after a 63-d preconditioning period where BRD morbidity rates were comparable to the rates seen in this study.

Three animals (3.9 %) had lung lesions present at slaughter. Similar to previous experiments, this study found that the presence of lung lesions was inconsistent with BRD treatment records (Gardner et al., 1999; Buham et al., 2000; Thompson et al., 2006; Holland et al., 2010). Only 1 of the 3 steers with lung lesions present at slaughter was treated for BRD during the stocker phase, and none were treated in the feedlot. Based on these results, we cannot conclude that the presence of lung lesions is an accurate way to determine the effectiveness of diagnosis and treatment protocols.

Feedlot Performance

Cattle were slaughtered in two different groups at a target of 1 cm of backfat. The first slaughter group was on feed for 162 d, and the second slaughter group was on feed for 197 d. This procedure is similar to what was described by Hersom et al. (2004) and

Holland et al. (2010). Both groups of researchers slaughtered animals when they reached a common compositional endpoint with approximately 1.27 cm of backfat. One difference between this study and previous studies conducted by Gardner et al. (1999) and Neel et al. (2007) is that they chose to slaughter animals at a common time endpoint rather than a common compositional endpoint. By finishing cattle to a common compositional endpoint, similar carcass composition at slaughter should be expected since all cattle are allowed to reach the same endpoint.

Results for the effects of stocker treatment on feedlot performance are presented in Table 4.1 and results for the effects of BRD during the stocker phase on feedlot performance are presented in Table 4.2.

There was no effect of receiving diet CP level on feedlot performance. During the stocker phase, cattle fed the higher CP diet (Diet 1) gained an additional 0.19 kg/d (P = 0.0008); however, stocker receiving diet did not affect feedlot ADG (P = 0.8755). Similarly, Hersom et al. (2004) found that increasing ADG during the stocker phase did not impact ADG during the finishing phase. This result differs from Neel et al. (2007) who reported that calves with lower ADG during the stocker phase had better ADG during the finishing phase due to compensatory gain.

Cattle receiving metaphylactic treatment in the stocker phase gained an additional 0.10 kg/d in the feedlot (P = 0.04). Similarly, in a meta-analysis conducted by Wileman et al. (2009), it was observed that cattle that were treated on arrival gained an additional 0.11 kg/d than animals that were not treated on arrival. Steers treated for BRD in the stocker phase (n = 43) gained an additional 0.10 kg/d (P = 0.04). This differs from the findings of Holland et al. (2010) who reported no difference in ADG during the finishing phase for calves treated for BRD during the preconditioning period compared to those not treated for BRD during the preconditioning period.

Cattle that received metaphylactic treatment during the stocker phase weighed 23.2 kg more ($P = 0.005$) at the end of the feedlot phase than cattle that did not receive metaphylactic treatment. Cattle that were treated for BRD during the stocker phase weighed 18.8 kg more ($P = 0.01$) than cattle not treated for BRD. In contrast, Holland et al. (2010) found that there was a linear decrease in BW as the number of BRD treatments during the stocker phase increased. For every additional kg of BW at the end of the stocker phase, final BW was increased by .55 kg ($P < 0.0001$). It is possible that the increase in ADG and final BW for calves treated for BRD in the stocker phase was due to the fact that some calves experienced a period of BRD, but did not show visual signs and therefore were not treated.

Steers harvested in Group 1 gained an additional 0.19 kg/d in the feedlot compared to steers harvested in Group 2 ($P < 0.0001$) and steers harvested in Group 1 tended to weigh more at the end of the finishing phase than steers harvested in Group 2 ($P = 0.07$). This differs from Holland et al. (2010) who reported that heifers slaughtered at a common compositional endpoint had similar final BW at the end of the finishing phase.

Carcass Performance

Results for the effect of stocker treatment on carcass performance are presented in Table 4.3 and results for the effect of BRD during the stocker phase on carcass performance are presented in Table 4.4.

There was no effect of receiving diet CP level on carcass performance. Cattle that received metaphylactic treatment during the stocker phase produced carcasses that were 13.2 kg heavier ($P = 0.003$) and tended to have more fat on their carcasses ($P = 0.09$). Cattle that were treated for BRD during the stocker phase produced carcasses that were 10.5 kg heavier ($P = 0.02$) than those not treated for BRD, and had 0.22 cm greater fat thickness ($P = 0.005$). For every additional kg of BW at the end of the stocker phase, HCW was increased by 0.35 kg ($P < 0.0001$), and LM area was increased by 0.07 cm^2 ($P = 0.0007$). Time of harvest affected HCW, and tended to be lesser in steers harvested in Group 2 ($P = 0.054$).

These findings differ from the results reported by Holland et al. (2010) who observed no differences in HCW, FT, or LM when comparing morbid and healthy animals slaughtered at a common compositional endpoint. Cattle used in the study conducted by Holland et al. (2010) were all British and British x Continental heifers. In the current study, a variety of breeds and breed types were represented. This variation in animal type could have led to some of the differences that were observed in carcass characteristics.

Overall, 51 % of the steers had a YG of 1 or 2 and 61 % of the steers produced a USDA QG of low choice or better. Five carcasses (6.6 %) received YG of a 4. Neither treatment was associated with QG ($P > 0.30$). Time of harvest affected QG. Steers that were harvested late (Group 2) had 0.06 greater odds of not grading choice ($P = 0.003$). Cattle that did not receive metaphylactic treatment during the stocker phase had 4.6 greater odds for having a YG of 1 or 2 ($P = 0.03$). Treatment for BRD during the stocker phase did not have an impact on QG ($P = 0.2955$) or YG ($P = 0.1077$). Similarly, Holland et al. (2010) observed no differences in YG, but did see a trend of decreasing marbling score as the number of BRD treatments increased. Schneider et al. (2009) reported that 16 % more nontreated animals graded choice than did animals treated for BRD.

Conclusions

Health, nutrition, and management during the stocker phase has been shown to impact subsequent animal performance. The exact effect of BRD on subsequent performance has yet to be discovered. Results still vary among current literature and this could be due to the fact that BRD is a complex of diseases involving numerous viral and bacterial pathogens.

Table 4.1 Effect of receiving diet CP level and metaphylaxis on feedlot performance[1,2]

	Treatment					
Item	Diet 1	Diet 2	P-value	Excede®	No Excede®	P-value
Feedlot ADG, kg/d	1.43 ± 0.46	1.46 ± 0.42	0.88	1.47 ± 0.44	1.42 ± 0.44	0.04
Final Feedlot BW, kg	561.7 ± 37.5	559.6 ± 33.0	0.70	568.8 ± 32.8	552.5 ± 35.8	0.005

[1]CP = crude protein, ADG = average daily gain, BW = body weight
[2]Mean ± standard deviation

Table 4.2 Effect of BRD diagnosis during stocker phase on feedlot performance[1,2]

	BRD during the stocker phase		
Item	Yes[3]	No[4]	P-value
Feedlot ADG, kg/d	1.47 ± 0.18	1.41 ± 0.23	0.04
Final Feedlot BW, kg	564.4 ± 33.2	555.7 ± 35.8	0.01

[1]BRD = bovine respiratory disease, ADG = average daily gain, BW = body weight
[2]Mean ± standard deviation
[3]N = 43
[4]N = 33

Table 4.3 Effect of receiving diet CP level and metaphylaxis on carcass performance[1,2]

	Treatment					
Item	Diet 1	Diet 2	P-value	Excede®	No Excede®	P-value
HCW	344.4 ± 25.6	344.7 ± 17.6	0.86	349.7 ± 21.7	339.3 ± 21.7	0.003
FT, cm	1.12 ± 0.30	1.07 ± 0.33	0.28	1.12 ± 0.38	1.04 ± 0.25	0.09
Marbling Score	5.30 ± 0.74	5.14 ± 0.83	0.39	5.21± 0.63	5.23 ± 0.96	0.86
REA, cm^2	79.4 ± 6.5	80.0 ± 7.4	0.40	80.0 ± 7.7	79.4 ± 6.4	0.74

[1]CP = crude protein, HCW = hot carcass weight, FT = fat thickness, REA = ribeye area
[2]Mean ± standard deviation

Table 4.4 Effect of BRD diagnosis during stocker phase on carcass performance[1,2]

	BRD during the stocker phase		
Item	Yes[3]	No[4]	P-value
HCW, kg	346.4 ± 20.5	342.1 ± 24.4	0.02
FT, cm	1.14 ± 0.30	1.02 ± 0.33	0.005
Marbling Score	5.23 ± 0.72	5.20 ± 0.87	0.73
REA, cm^2	79.4 ± 6.5	80.6 ± 7.7	0.57

[1]BRD = bovine respiratory disease, HCW = hot carcass weight, FT = fat thickness, REA = ribeye area
[2]Mean ± standard deviation
[3]N = 43
[4]N = 33

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