IMPACT OF HEALTH MANAGEMENT, HEALTH TREATMENTS AND ZILPATEROL HYDROCHLORIDE SUPPLEMENTATION ON CARCASS, COLOR AND PALATABILITY TRAITS

By

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

Beef producers constantly want to be aware of how to make their production practices and cattle more efficient. This comes in the form of amount and quality of product, which translates to dollars in the most efficient and effective way possible. Combined with environmental factors, growth rate and efficiency directly impact the health of cattle. Respiratory infections, such as Bovine Respiratory Disease (BRD) and other chronic health problems, are a detriment to the performance of the cattle. The National Agriculture Statistics Survey reports that respiratory disease costs the beef industry nearly $700 million dollars annually and that this disease complex accounts for 75% of feedlot morbidity and 50% of mortality (Martin et al., 1989; Edwards, 1996).

Unfortunately, proper clinical evaluation may be difficult when diagnosing cattle potentially affected by BRD, which is commonly diagnosed by visual assessment of any number of observable symptoms. Once an animal is deemed infected with the disease a course of treatment is set for them. This means trips to the chute as well as stress from handling along with the animal already in a depressed state. Animals exhibiting illness during finishing often experience a decrease in body weight, which could lead to a decrease in both external and internal fat, having a negative effect on both quality and yield grade, detracting from the value of the carcass. This would, in turn, cause a negative eating experience as it has been long known that sensory traits such as tenderness, juiciness and palatability are associated with quality grade and the lower the quality grade, the better chance to have a negative eating experience.

In terms of making cattle more efficient, some producers have turned to feeding supplements, such as zilapaterol hydrochloride (ZH, Zilmax, Intervet Inc., a part of Schering-Plough Corporation, Millsboro, DE). It is a new beta-adrenergic agonist (BAA), which is used to improve animal composition. Beta-adrenergic agoninsts have been shown to increase lean muscle and decrease fat deposition, but at the same time have a negative effect on beef tenderness. Studies conducted with ZH have increased longissimus muscle shear force and decreased sensory tenderness scores (Sytrdom et al., 1998; Strydom and Nel, 1999; Hilton et al., 2009).

As such, the objectives of this experiment were 1) determine the impact of health monitoring and health treatments on carcass, color and palatability traits and 2) determine the impact of health monitoring treatments and zilpaterol hydrochloride supplementation on carcass, color and palatability.

CHAPTER II

REVIEW OF LITERATURE

Introduction

Beef producers must always be aware of how to make their production practices and cattle more efficient not only in terms of dollars, but pounds gained per day and the cost that is associated with reaching market weight as efficiently and cost effective as possible. Along with the environment, another major impact on the growth rate and efficiency of cattle is their health. Chronic health problems, especially respiratory infections, can be a detriment to the performance of cattle. Respiratory disease costs the beef industry more than $690 million annually (National Agricultural Statistics Service, 2006). Economically, the most important disease affecting feedlot cattle throughout North America is the bovine respiratory disease (BRD) complex (Martin et al.,1989; Edwards, 1996).

It has been reported by Fulton et al. (2002) that calves treated for BRD once returned $40.64 less, calves treated twice returned $58.35 less and calves treated 3 or more times returned $291.93 less than calves that were not treated. As it has been stated numerous times, BRD is the most costly disease that affects the beef industry each year, and undoubtedly, any reduction in the instances of this disease would allow for greater economic return for the producers, whether they are selling cattle without retaining ownership, or retaining ownership and selling on the grid. Pricing cattle based on carcass merit has the veterinary profession to reevaluating the cost of BRD as well as other diseases affecting feedlot cattle. The cost of disease when cattle are sold on a live weight basis is determined as loss due to death, treatment cost, decreased feed efficiency, and decreased live weight. When cattle are sold on a carcass merit basis, disease has the potential to affect not only carcass weight, but also the quantity, location and ratio of muscle, fat and water (Larson, 2005).

Bovine Respiratory Disease

Bovine respiratory disease is a complex of diseases characterized by many types of infection, each having its own causes, clinical signs, and economic implications. Prevalent microbial causes for BRD include viral (infectious bovine respiratory rhinotracheitis, bovine viral diarrhea, bovine respiratory syncytial, and parainfluenza type 3), bacterial (*Mannheimia haemolytica, Pasteurella multocida, Haemophilus somnus*), and mycoplasmal (Ellis, 2001). Shipping and processing feedlot calves enhances predisposing causes and increases environmental risk factors. Predisposing causes (Callan and Garry, 2002) are generally synergistic and include age, stress (comingling, weather, nutritional changes, etc.), and immunological background. Environmental risk factors include climate, ambient temperature, dust particles, stocking density, humidity, ventilation, and shipping distance.

This disease complex accounts for approximately 75% of feedlot morbidity and 50% of mortality (Edwards, 1996). In 1999, most feedlots (97.4%) within 12 states reported an overall BRD incidence of 14.4% (NAMHS, 2000a). Although the medical costs attributable to the treatment of BRD are substantial (Martin et al., 1982; Perino, 1992), the economical impact of BRD on performance may be even more devastating. Treatment costs for BRD averaged $15.57 per sick animal. McNeill et al. (1996) reported that “healthy” steers had higher daily gains (1.33 vs. 1.26 kg/d) and 12% more USDA Choice carcasses than cattle defined as “sick at some point during the finishing period.” Martin et al. (1989), Bateman et al. (1990), and Morck et al. (1993) reported that gains were lower for feedlot cattle treated for BRD.

Unfortunately, proper clinical evaluation may be an issue when diagnosing cattle potentially affected by BRD. Wittum et al. (1996) found that even though 45% of 469 steers were medicated for respiratory disease between birth and slaughter, 72% had pulmonary lesions at slaughter well as 28% had respiratory tract lesions in treated cattle; this may indicate that the medical treatment was successful and resulted in resolution of lung damage (Gardner et al.,1999).

Early administration of an effective antimicrobial, such as Draxxin, at the appropriate dose is beneficial for the successful treatment of BRD-affected animals (Icen et al., 2009). It has been reported by Kilgore et al. (2005a, b), Rooney et al. (2005) and Nutsch et al. (2005) that tulathromycin (Draxxin) given to calves at high risk of developing BRD was significantly more effective in reducing BRD morbidity and mortailty compared with florfenicol (Nuflor) and tilmicosin (Micotil). Tulathromycine (Draxxin) is effective not only in the treatment of the respiratory disorders, but also in the prevention of the appearance of clinical signs of BRD in the animals sharing same space (Icen et al., 2009).

Bovine respiratory disease and other respiratory diseases are commonly detected by visual assessment of any number of observable symptoms such as depression, lack of fill, altered gait, ocular or nasal discharge or general weakness (Gardner et al., 1999, Berry et al., 2004; Rose-Dye et al., 2010). After clinical symptoms are observed, illness can be confirmed by elevated body temperature, which is typically monitored rectally (Baker and Merwin, 1985; Gardner et al., 1999; Berry et al., 2004, Rose-Dye et al., 2010). Rectal temperature is a key indicator of illness that can be difficult to obtain in many settings, especially large commercial productions, or those without proper capture and working facilities (Rose-Dye et al., 2010). With the progression of technology, it has been speculated that disease could be determined using rumen temperature boluses, which could provide a safe, easy, fast determination of cattle well being, which is both non-invasive and non-stressful for the animal. Minimal research has been done on this possible avenue. Most research conducted has been able to link the rumen temperature to temperature of other core body locations. Rumen temperatures generally follow the same patterns as other core body locations, with the exception to the consumption of water, which will decrease rumen temperature, which may last up to 3.5 h (Darcy and Kurtenbach, 1968; Beatty et al., 2008; Brod et al., 1982; Bewley et al., 2008). Rose-Dye et al. (2010) found that remote monitored rumen temperature boluses will provide temperature results that are highly correlated with rectal temperatures.

Impact on Carcass Traits

The negative effects on live weight can be carried over to cause decreased hot carcass weights, dressing percentage, external as well as intramuscular fat, and therefore, a reduction in both quality and numerical yield grade. Gardner et al. (1999) found that Charlois steers which were affected with BRD at least once during the finishing period were leaner than unaffected steers, this was confirmed by Garcia et al. (2010), who found a decrease in yield grade and adjusted fat thickness. Lower marbling scores and lighter hot carcass weights of those affected with BRD compared to those unaffected have been shown by Montgomery et al. (1984), Gardner et al. (1999), Roeber et al. (2001), Montgomery et al. (2009), and Schneider et al. (2009). These problems undoubtedly cause a negative association with tenderness, juiciness and palatability, as it has long been known that these traits are associated with quality grade, and the lower the quality grade, the better chance of having a negative eating experience. Nevertheless, Gardner et al. (1999) reported that 90 to 100% of steaks registered a Warner-Bratzler Shear Force (WBSF) of 3.84 kg or less once they were aged for at least 14d.

As expected, a decline in animal health, as well as increased stress caused by illness, requires more trips to the chute, more handling by humans and more medication will in turn cause a decline in carcass traits. In a study conducted by Gardner et al. (1999), when comparing cattle that either were treated or not treated, the cattle treated once or more had lower final weights, decreased fat thickness and decreased marbling score. Gardner et al. (1999) also had an increased percentage of USDA Standard carcasses, with none of the cattle being treated more than once grading USDA Choice. Also, cattle that had active vs. inactive lung lesions also had decreased carcass traits. Although, in both cases where the cattle who were sick and treated most often had the highest initial body weights, the cattle who had active lung lesions had a decreased final body weight, decreased dressing percentage, decreased fat thickness and decreased marbling score.

Warner-Bratzler Shear Force and Sensory Evaluation

When WBSF was analyzed on cattle who had 0, 1 or 2 hospital visit, Roeber et al.

(2001) stated that neither morbidity history nor preconditioning treatment affected shear force values, as well as ratings for tenderness and juiciness as determined by members of a trained taste panel. The only differences existed in this trial (Roeber et al., 2001) were among degrees of doneness and not the actual health history. Additionally, Gardner et al. (1999) reported that WBSF did not increase for steaks between steers treated once or more than once for BRD. Holland et al. (2010) also showed that previous treatment for BRD was not associated with decreased tenderness and this was consistent with Snowder et al. (2007) who did not observe a significant correlation between respiratory disease and WBSF. No differences were shown by Snowder et al. (2007) for calves treated for BRD and longissimus muscle palatability traits.

The most important factor which influences consumer satisfaction for beef palatability is tenderness (Miller et al., 2001; Savell et al., 1987, 1989; Smith et al., 1987). According to Miller et al. (2001), consumers who sampled steaks which had a WBSF value of 4.0 kg or less gained consumer tenderness acceptability ratings of 94 - 100%.

Color Evaluation

The visual appearance of a meat product determines the consumer's decision to buy or not buy that product at retail and to eat or not eat that product (MacKinney et al., 1966). Kropf (1980) reported that color is probably the single greatest appearance factor that determines whether a meat cut will be purchased. Muscle color is also one of the factors used to determine USDA quality grades for beef carcasses (USDA, 1997). The USDA graders must consider muscle color as related to carcass maturity and muscle color as related to muscle pH (dark cutters; Wulf and Wise, 1999). Measuring muscle color in beef carcasses is also important because several researchers have demonstrated a relationship between ultimate muscle pH (Purchas, 1990; Watanbe et al., 1995) and (or) muscle color (Jeremiah et al., 1991; Cannell et al., 1997; Wulf et al., 1997) and meat tenderness.

Objective measures of color are L*, a* and b*. A popular instrument for obtaining this information is to use a HunterLab device. HunterLab (2008) states that the CIELAB color scale is an approximately uniform color scale. Additionally, HunterLab (2008) notes that the maximum for L* is 100, which represents a perfect reflecting diffuser, or white. The minimum for L* is 0, which represents black. The a* and b* axes have no specific numerical limits. Positive a* is red and negative a* is green. Positive b* is yellow and negative b* is blue.

It is recommended by Wulf and Wise (1999) that when measuring L* value, the measurer allow at least 33 min of bloom time. When measuring either a* or b*, a time of 78 min should be allowed of bloom time. If either of these is not able to be met, at least 10 min of bloom time should be allowed, and then adjusted to a 90 min bloom time according to the factors listed in that publication. A 10 min bloom time is recommended, as that is what is outlined in the USDA guidelines. The research proposed by Wulf and Wise (1999) determines the need for printed color standards for beef muscle to classify dark cutting beef carcasses and to sort out beef carcasses with potentially tough meat. Gardner et al. (1999) evaluated color on cattle that were treated zero times, once and more than once and cattle that were treated more than once had a slightly lighter colored appearing lean in comparison to those treated once or zero times. This could cause a negative impact with consumers as consumers are not used to seeing the light pink or more youthful beef color; they associate beef with being bright cherry red, or just closer to red than pink, so disease could also impact consumer acceptability when it comes to retail color.

Zilpatol Hydrochloride

Beta-adrenergic agonists (BAA) are used to impact animal composition, and have been a hot topic for animal researchers for many years. Over the last twenty years, animal researchers have been interested in zilpaterol hydrochloride (Zilmax, Intervet Inc., a part of Schering-Plough Corporation, Millsboro, DE) a new BAA Antimicrobial commercially available in Mexico, the Republic of South Africa, and the United States as Zilmax. Beta-adrenergic agonists such as clenbuterol and cimaterol have been shown to function as repartioning agents, increasing lean muscle and decreasing fat deposition (Ricks et al., 1984; Molooney et al., 1990; Chikhou et al., 1993). Beta-adrenergic agonists have been shown to have negative effects on shear force values. The B1 agonist, ractopamine hydrochloride, has been shown to increase beef tenderness, WBSF and decrease sensory tenderness scores when supplemented at approximately 300mg/animal per day (Schroeder et al., 2003a). Studies conducted with zilpaterol hydrochloride in cattle have increased beef WBSF and decreased sensory tenderness scores in the longissiumus muscle (LM), whereas effects on semitendinosus shear force and tenderness are much more variable (Sytrdom et al., 1998; Strydom and Nel, 1999; Hilton et al., 2009).

It was first reported by Plascencia et al. (1999) that zilpaterol hydrochloride treatment of steers significantly improved carcass cutability of boneless, closely trimmed subprimal cuts including the neck, inside skirt, top sirloin, knuckle and top round. Hilton et al. (2009) was in agreement in reporting that zilpaterol treatment of steers resulted in a significant increase in subprimal cutability of the shoulder clod, chuck tender, knuckle, top round, outside round, eye of the round strip loin, top sirloin butt, ball tip, full tenderloin, and flank steak, whereas trimmable fat was decreased.

There has been speculation that some tenderness issues would arise with the supplementation of zilpaterol hydrochloride, as there has been with other repartitioning agents. According to Leheska et al. (2009) feeding steers zilpaterol decreased calculated percentage empty body fat and increased 28% adjusted final BW. Also, feeding zilpaterol increased WBSF by 22% and decreased overall tenderness scores by 4%. Studies in cattle that have been conducted with zilpaterol hydrochloride supplementation have shown increased WBSF and decreased sensory tenderness scores (Strydom et al., 1998; Strydom and Nel, 1999; Hilton et al., 2009).

Color of meat is used by consumers to determine freshness, perceived eating quality, and desirability (Cassens et al., 1988). Consumers prefer a bright red lean color (Carpenter et al., 2001) and do not purchase beef steaks when lean surface metmyoglobin reaches 30 to 40% (Gee and Brown, 1980). Although fresh meat lean color and discoloration are not directly related to nutrition, microbiology, or quality (Zhu and Brewer, 1998), lean color continues to directly influence purchase decisions. There have been numerous reports on the meat color and shelf life of zilpaterol hydrochloride supplemented cattle. Strydom et al. (2000) found that traditionally packaged LM from South Africa for 30 and 50 d had more acceptable lean color scores than control steaks in dark storage. Supplementation of ZH for 20 and 30 d resulted in steaks with a more red lean color than 0 d of supplementation on d 2 and 3 of display. By d 4 of display, steaks from beef cattle fed ZH for 20 d were redder than those from beef cattle fed ZH for 0, 30, and 40 d. These results are similar to those of Hilton et al. (2009), who reported that ZH supplementation increased the LM color scores of trained panelists throughout a 5-d display period.

Conclusion

Bovine respiratory disease impacts the industry year after year, and beef producers must find a way to either prevent or treat BRD in the most economical way possible, without having a negative effect on the carcass. If possible, metaphylactic treatment with an antimicrobial could prevent the disease from developing and prevent further trips to the chute, which would cause less stress on the animals. Since meat is the end product of the beef industry it is important to determine what correlation, if any exists between health and number of treatments and how it affects beef as it relates to consumer acceptability. It is important to understand how treatment of disease impacts the quality of the meat and how it will affect the color and retail display. Overall appearance is the first thing that is noticed when a consumer approaches meat in the retail case, and beef producers don’t want to unwillingly engage in any practices that might damage the shelf life of the product, this is why it is important to study the correlation between treatment of disease and its effects on meat quality and as well as color, but subjective and objectively. Also, more research needs to be conducted on cattle that will be supplemented with zilpaterol hydrochloride and have BRD, as well as be treated to determine what effects it has on beef palatability characteristics, especially color and shelf life.

CHAPTER III

IMPACT OF HEALTH MANAGEMENT, HEALTH TREATMENTS AND ZILPATEROL HYDROCHLORIDE SUPPLEMENTATION ON CARCASS QUALITY, COLOR AND PALATABILITY TRAITS

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ABSTRACT

Two hundred sixty eight strip loins were collected from heifers fed at Oklahoma State Univesity in Stillwater, OK. In phase I, 127 heifers were assigned to one of three treatment groups. Antimicrobial administrations (AA) were given based on visual assessment (VA), rumen temperature (RT) or given a metaphylactic treatment of Draxxin (MT) followed by visual assessment. In phase II, 155 heifers were assigned to two treatment groups, control (CON) and zilpaterol hydrochloride (ZH). Three steaks were collected from each strip loin, one each for retail display, sensory evaluation and Warner-Bratzler shear force (WBSF). Color was evaluated from the retail display steak using a trained color panel and objectively using a HunterLab Miniscan XE. An Instron

Universal Testing Machine with a Warner-Bratzler head was used for evaluation of instrumental tenderness, and a trained sensory panel was used to assess palatability traits. Heifers treated by VA had the least number of AA, lowest yield grade and also had the lightest hot carcass weights compared to the heifers treated by the other health management protocols. There were no subjective color attribute differences or sensory panel differences across all health management systems or AA. There were no differences in carcass and performance traits for any AA treatment groups. Heifers who had 0 or 1 AA had lower a* and b* values compared to those who had 2 AA. In phase II, heifers treated by VA had the least number of AA when compared with MT and RT. Health management group did not have any other effects in carcass, sensory or color attributes. Across all AA, fat thickness, internal fat and marbling all decreased as AA increased. Zilpaterol hydrochloride supplementation caused a decrease in internal fat and yield grade, but no interactions between the number of AA and ZH supplementation. As AA increased, tenderness increased and amount of detectable connective tissue decreased. With the supplementation of ZH, there was a negative effect on tenderness, which caused a significant increase in WBSF. At the end of the retail display, the control group had a greater amount of surface discoloration when compared to the ZH group.

Key Words: health, BRD, beta agonist

INTRODUCTION

Beef producers always want to be aware of how to make their production practices and cattle more efficient not only in terms of dollars, but pounds gained per day. In order to manage this, costs must be decreased which are associated with allowing cattle to reach market weight as efficiently and cost effective as possible. Along with the environment, another major impact on the growth rate and efficacy of cattle is health. Chronic health problems, especially respiratory infections, can be a detriment to the performance of the cattle. Economically, the most important disease affecting feedlot cattle throughout North America is bovine respiratory disease (BRD) complex (Martin et al., 1989; Edwards, 1996). Respiratory disease costs the beef industry more than $690 million annually (National Agricultural Statistics Service, 2006). This disease complex accounts for approximately 75% of feedlot morbidity and 50% of mortality (Edwards, 1996). In 1999, most feedlots (97.4%) within 12 states reported an overall BRD incidence of 14.4% (NAMHS, 2000a). Although the medical costs attributable to the treatment of BRD are substantial (Martin et al., 1982; Perino, 1992), the economic impact of BRD on performance may be even more devastating. McNeill et al. (1996) reported that "healthy" steers had higher average daily gains (1.33 vs. 1.26 kg/d) and 12% more US Choice carcasses than cattle defined as "sick" at some point during the finishing period. Martin et al. (1989), Bateman et al. (1990), and Morck et al. (1993) reported that gains were lower for feedlot cattle treated for BRD.

Unfortunately, proper clinical evaluation may be difficult when diagnosing cattle potentially affected by BRD. Wittum et al. (1996) found that even though 45% of 469 steers were medicated for respiratory disease between birth and slaughter, 72% had pulmonary lesions at slaughter. Diseases such as BRD are commonly detected by visual assessment of such as depression, lack of fill, altered gait, ocular or nasal discharge or general weakness (Rose-Dye et al., 2010, Gardner et al., 1999, Berry et al., 2004). After clinical symptoms are observed, an illness can be confirmed by elevated body temperature, which is monitored rectally (Rose-Dye et al., 2010, Baker and Merwin, 1985; Gardner et al., 1999; Berry et al., 2004). Rectal temperature is a key indicator of illness that can be difficult to obtain in many settings, especially large commercial operations, or those without proper handling and working facilities (Rose-Dye et al., 2010).

With the progression of technology, it has been speculated that disease could be diagnosed using rumen temperature boluses. Rumen boluses are easily administered and could provide a safe, easy, fast determination of cattle well being. There has been minimal research done on this possible avenue. Most of the research, which has been conducted, has been able to link the rumen temperature to temperature of other core body locations. Rumen temperatures generally follow the same patterns as other core body locations. One exception is the consumption of water, which will decrease rumen temperature, for up to 3.5 h (Darcy and Kurtenbach, 1968; Beatty et al., 2008; Brod et al., 1982; Bewley et al., 2008). Rose-Dye et al. (2010) found that remote monitored rumen temperature boluses will provide temperature results that are high correlated with rectal temperatures.

Additionally, the negative effects of health on live performance can be carried over to decreased hot carcass weights, dressing percentage, external fat, intramuscular fat and, therefore, a reduction in both quality and yield grade. These problems typically cause a negative association with tenderness, juiciness and palatability. Nevertheless, Gardner et al. (1999) reported that treatment for respiratory disease did not decrease tenderness of longissimus muscle steaks.

As such, the objectives of this experiment were: 1) determine the impact of health management protocol and antimicrobial treatments on carcass, color and palatability traits and 2) determine the impact of health management protocols and zilpaterol hydrochloride supplementation on carcass, color and palatability traits.

MATERIALS AND METHODS

Cattle and Treatments- Phase I

Strip loins were collected from mixed breed heifers, (n = 125), which were fed at Oklahoma State University's Willard Sparks Beef Research Center in Stillwater, OK. Heifers were blocked by body weight (2 blocks) and stratified using coat color. Using SAS, (Cary, NC) during phase I, heifers were assigned randomly to a pen. Treatments were administered based on visual assessment (VA), rumen temperature (RT) or metaphylactic treatment followed by visual assessment (MT). Cattle were harvested in Dodge City, KS, on either January 6, 2010, or February 10, 2010.

Cattle and Treatments – Phase II

Strip loins were collected from mixed breed heifers, (n = 143), which were also fed at Oklahoma State University's Willard Sparks Beef Research Center in Stillwater, OK. During phase II, the heifers were assigned randomly to a pen and also by two treatment groups, control (CON) and zilpaterol hydrochloride (ZH). Cattle were also assigned to treatments based on VA, RT or selected for MT as stated above. Cattle were shipped to a commercial harvest facility for harvest and data collection. Heifers were shipped to Amarillo, TX, and were harvested either March 10, 2010, or March 31, 2010.

Grading and Fabrication – Phase I and II

Following harvest, carcasses were chilled following facility procedures and then graded by Oklahoma State University personnel. Following grading, strip loins were marked to maintain identity and were followed through fabrication. All strips were fabricated on site into 1 × 0 boneless strip loins. Strips were packaged, boxed and transported back to Oklahoma State University where they were aged for 14 d prior to further fabrication.

Sample Preparation, Strip Loins – Phase I and II

After 14 d of aging at 4^{o}C, each strip loin was faced on the anterior end and three 2.54 cm steaks were cut. The first steak was placed in a styrofoam tray with a soaker pad and overwrapped with a polyvinyl chloride film and placed directly under retail lighting. The second and third steaks were vacuum packaged and frozen in a blast freezer (-20^{o}C) for subsequent Warner-Bratzler shear force analysis and sensory analysis.

Simulated Retail Display – Phase I and II

Steaks packaged and identified for retail display were packed as previously described and placed in a display case, which was maintained at an average temperature of 1.95 +/- 1^{o}C, under continuous lighting conditions (Philips Delux Warm White Fluorescent lamps; Andover, MA). The surface of the meat was exposed in the case to 807-1,614 lux for the entire period in retail display. Steaks were rotated daily.

Subjective Color Evaluation – Phase I and II

An eight-person panel of trained Oklahoma State University personnel evaluated color subjectively every 12 h during retail display. Panelists were trained using Munsell color tiles (Gretagmacbeth, New Windsor, NY) and had to achieve a passing score before serving on the color panel. Strip steaks were evaluated based on muscle color score, surface discoloration (% metmyoglobin), and overall acceptability. Muscle color was scored using an 8-point scale (1=extremely dark red, 8=extremely bright cherry red); surface discoloration was evaluated on a 7-point scale (1 = no discoloration, 7 = total discoloration) and overall acceptability on an 8-point scale (1= extremely undesirable, 8 = extremely desirable; American Meat Science Subjective Color Evaluation Guidelines, 1991).

Objective Color Evaluation – Phase I and II

Objective color was evaluated using a HunterLab Miniscan XE spectrophotometer equipped with a 6 mm aperture (HunterLab Associates Inc., Reston, VA) following the procedures of the Commission Internationale de I'Eclairage (CIE, 1976) to determine color coordinate values for L* (brightness: 0 = black; 100 = white), a* (redness/greenness: positive values = red, negative values = green), and b* (yellowness/blueness: positive values = yellow, negative values = blue). Objective measurement of for steaks began with the initial display time and continued every 12 h until 156 h. Three readings were taken from each steak twice daily at 12 h intervals and those values were averaged to get the final L*, a*, and b* values for each steak. Hours 0, 72 and 156 were analyzed as a beginning, middle and end of retail display measurement.

Warner-Bratzler Shear Force – Phase I and II

Prior to Warner-Bratzler Shear Force (WBSF) evaluation, steaks were allowed to temper at 4^{o}C for 24 h. The steaks were cooked using an impingement oven (XLT Ovens, Model 3240TS2, BOFI, Wichita, KS) to an internal temperature of 70^{o}C. After cooking, steaks were allowed to cool for 24 h at a temperature of 2^{o}C. After cooling, six cores (1.27 cm in diameter) from each steak were removed parallel to the muscle fiber orientation. Each core was sheared once using the Warner Bratzler head on an Instron Universal Testing Machine (model 4202; Instron Corp., Canton, MA) at a crosshead speed of 200 mm/min. Peak force (kg) of core was recorded by an IBM PS2 (Model 55SX) using software provided by the Instron Corporation. Mean peak WBSF was determined for each steak by averaging the six cores.

Sensory Evaluation – Phase I and II

Each sensory session was randomized to include steaks from all treatment groups. Steaks were tempered for 24 h prior to cooking then cooked as described above for WBSF. Immediately following cooking, steaks were cut into 1cm × 1cm × 2.54 cm pieces and placed into a cup with the corresponding number. The numbers were different than the originally assigned numbers so that they would be chronological and would not reflect the original identification number. Cups were placed in individual warmers with heat packs in order to keep samples warm during the sensory session. The sensory panel consisted of eight trained panelists (Cross et al., 1978) who were seated in individual booths under red lights in a temperature and light controlled room. The panelists evaluated (AMSA, 1995) the steaks for initial and sustained juiciness (1 = extremely dry, 8 = extremely juicy), initial and overall tenderness (1 = extremely tough, 8 = extremely tender), and connective tissue amount (1 = abundant, 8 = none). Flavor attributes were not evaluated, but each panelist had an available spot on the ballot to denote any off flavors. Twelve samples were consumed per session in a randomized order. Distilled, deionized water an unsalted crackers were provided to each panelist to cleanse their palate between samples. There were two sessions per sitting and sessions were separated by a 10 to 15 min break.

Statistical Analysis

Data was analyzed using the mixed procedure of SAS as a completely randomized design with the animal as the experimental unit (EU) and strip loin as the sampling unit for WBSF and color analysis. The analysis of variance (ANOVA) model included supplement (ZH, CON) and health management (VA,MT,RT) or antimicrobial administrations (0, 1, 2+) as the fixed effect and carcass identification number as the random effect. Interactions were also analyzed, however, when the interaction was not significant, it was removed from the model and only main effects were analyzed. When the model indicated a significant ($P < 0.05$) treatment effect, lease squares means were separated using a pairwise t-test. Phase I included health management system or Antimicrobial administrations as the fixed effect and carcass ID as the random effect. The model for phase II included Zilpaterol Hydrochloride, control, health management system or antimicrobial administrations as the fixed effect with carcass ID as the random effect.

RESULTS AND DISCUSSION – PHASE I

Performance and carcass traits for heifers treated by VA, MT or RT

Heifers who were assessed for symptoms of BRD through MT and RT were treated more often than VA ($P < 0.0001$, Table 1). For the heifers treated with MT, this treatment was recorded in the AA record, and therefore, since MT has a value of 1.02, this reflects the initial dosage of Draxxin, which was part of the protocol for this treatment group and subsequent treatments were limited to 2. According to retail prices, 1 mL of Draxxin costs between $3.99 and $4.50. Average weight of heifers used in this trial at receiving was 241 kilograms, which would make total cost of treating a heifer between $21.14 and $23.85, which is above a cost of $15.57. In a study conducted by Schneider et al. (2009) 75% of cattle treated were done so within 40d, which reinforces the concept that initial entry into a feedlot is an important time to observe cattle for signs of BRD. This could also be an important time to administer metaphylactic treatment to cattle in order to avert future respiratory infections. Tulathromycine (Draxxin) is effective not only in the treatment of the respiratory disorders, but also in the prevention of the appearance of clinical signs of BRD in the animals sharing same space (Icen et al., 2009). Additionally, heifers, which were treated by VA, when compared to MT and RT had the lowest numerical yield grades (P = 0.003), the least fat thickness (P = 0.006) and lowest hot carcass weights (P = 0.058). Heifers treated using MT and RT showed no differences for AA, YG and HCW. Values for longissimus muscle area, internal fat and marbling score across all treatments revealed no differences. Similar marbling scores being found across all levels of AA is contradictory to several studies (Montgomery et al.,1984 ; Gardner et al., 1999 ; Roeber et al., 2001; Montgomery et al., 2009 ; Schneider et al., 2009), all of which reported lower marbling scores for those affected with BRD compared to those unaffected.

Sensory Panel Attributes of heifers treated by VA, MT or RT

In sensory traits evaluated by the panelists, samples from each treatment group were similar in values for initial and sustained juiciness, tenderness, overall impression and connective tissue following 14 d of postmortem aging. The subjective sensory characteristic evaluators measured all characteristics at a desirable range on the scale. Treatment administration did not affect any of the sensory characteristics. Gardner et al. (1999) also reported that treatment for respiratory disease did not decrease tenderness of longissimus muscle steaks. Across all treatments, WBSF values remained at 3.30 kg or below, which would result in 99% acceptability from consumers (Miller et al., 2001).

Subjective Color Evaluation of heifers treated by VA, MT or RT

There were no differences for trained color panelists for any of the color evaluation attributes (Table 3). As time went on through the end of retail display, muscle color became less cherry red, surface discoloration increased and overall appearance eventually decreased to the undesirable range, however, this was after a display period of 156 h. These decreases ($P \geq 0.59$) not be associated with treatment and are typical of retail display time associated with exposure to light and oxygen. Steaks were still maintaining an acceptability level of over 6 at 72 h.

Objective Color Evaluation of heifers treated by VA, MT or RT

Regardless of treatment group, all steaks darkened and discoloration appeared over time, however, there were no differences shown for any of the objective color evaluation measures (L*, a* or b*). Values for L* held steady across the entire retail display period, however, a* decreased in value as steaks became less red and more discoloration was evident (Table 4).

Performance and carcass traits for heifers treated 0, 1 or 2 or more times

All carcasses had average marbling scores of Small^{00} or higher and yield grades were similar as were longissimus muscle area and fat thicknesses (Table 5). Holland et al. (2010) reported no difference for HCW among BRD treatment categories and a tendency for marbling scores to decrease, but no other differences in carcass characteristics were shown due to number of treatments for BRD. This is contradictory to Garcia et al. (2010), which reported that cattle treated for BRD had significantly less fat thickness as well as decreased yield grade than those left untreated. Decreased marbling scores and HCW as BRD treatments increased was reported by Schneider et al. (2009). Across all treatment levels, there were no effects on carcass traits, reflecting no detriment to the carcass value if cattle were treated properly. However, since this treatment protocol involves an metaphylactic treatment of Draxxin and very few of those cattle had to be retreated, it shows an economical advantage to treat received cattle with Draxxin to avoid further treatment, especially when compared to treatment using RT, when the cost of the bolus alone is more than one treatment of Draxxin. This would also involve an initial handling to insert the bolus as well as a subsequent handling to administer treatment.

Sensory panel attributes of heifers treated 0, 1 or 2 or more times

No significance was found for any of the sensory characteristics (Table 6), including WBSF. Similar results were found for WBSF by Holland et al. (2010). However, Garcia et al. (2010) stated that animals not treated for BRD had significantly greater shear for values. Additionally, WBSF levels remained at 3.23 kg or below which would account for 99% of consumer acceptability (Miller et al., 2001). Furthermore, those with 2 or more AA had the least amount of detectable connective tissue by the panelist and 1 AA had the highest detectable connective tissue amount, which trended towards significance (P = 0.09).

Subjective Color Evaluation of heifers treated 0, 1 or 2 or more times

There were no differences for Phase I for any of the color evaluation attributes (Table 7). As expected, muscle surface color declined, discoloration increased and overall acceptability decreased, however, none of these could be attributed to the treatment or non-treatment for BRD. Holland et al. (2010) also reported muscle surface color and overall acceptability decreasing over time coupled with increased discoloration, but that no pattern in the decline of color or overall appearance could be attributed to BRD.

Objective Color Evaluation of heifers treated 0, 1 or 2 or more times

The a* values trended toward a difference ($P = 0.06$), while the b* showed a significant difference ($P = 0.04$) for the 72 h of objective color evaluation. Of course, as previously mentioned, as time went on, muscle color darkened, surface discoloration increased and overall acceptability declined. Holland et al. (2010) showed that steaks coming from cattle treated 2 times had more surface discoloration.

RESULTS AND DISCUSSION – PHASE II

Performance and carcass Traits of heifers treated by VA, MT or RT as well as supplemented with Zilpaterol Hydrochloride or Control

There was a difference in health management protocol with heifers treated by VA having the lowest values ($P = 0.05$) at 0.85 and those treated by MT and RT being the highest, at 1.35 and 1.29, respectively (Table 9). There was no significant effect on marbling scores, which was also shown by Casey et al. (1997) and Plascencia et al. (1999). Significant differences were shown for internal fat for those supplemented with ZH ($P = 0.03$), in contrast Casey et al. (1997) and Plascencia et al. (1999) did not show a difference for internal fat. In the present study, there was also a significant difference in yield grade ($P = 0.01$). Similarly, in a study conducted by Montgomery et al. (2009) ZH supplementation resulted in a 10% decrease in yield grade for heifers fed in the study. However, they did not see a difference in internal fat, which was also shown by Casey et al. (1997); Plascencia et al. (1999). Montgomery et al. (2009), also showed a tendency for marbling scores to be decreased with ZH supplementation, which was not shown in the current study.

Sensory panel attributes of heifers treated by VA, MT or RT as well as supplemented with Zilpaterol Hydrochloride or Control

There were no differences shown for any of the sensory attributes including WBSF (Table 10), however all shear force values across all treatments remained at an acceptable tenderness level for consumers (Miller et al., 2001). Cattle fed ZH had steaks with higher ($P = 0.0002$) WBSF values than steaks from cattle not fed ZH. This is in agreement with several other studies that fed cattle ZH for 20 d prior to harvest (Hilton et al., 2009; Shook et al., 2009).

Subjective Color Evaluation of heifers treated by VA, MT or RT as well as supplemented with Zilpaterol Hydrochloride or Control

Muscle color became darker, surface discoloration increased and overall appearance decreased as retail case storage time increased, however, none of these changes in variables were dependent on the treatment, except at the 156 h for muscle color, the CON group had a greater amount of surface discoloration ($P = 0.03$; Table 11). VanOverbeke et al. (2009) reported that zilpaterol supplementation had no effect on discoloration scores.

Objective Color Evaluation of heifers treated by VA, MT or RT as well as supplemented with Zilpaterol Hydrochloride or Control

There were no differences shown for objective color evaluation of L*, a* or b* (Table 12). The L* values remained similar throughout all treatments and throughout the retail display time. In addition, a* values moved away from red and became closer to green on the spectrum as surface discoloration increased. Also, b* values faded away from yellow as the display simulation continued. There has been previous research which has shown an increase in a* values in meat color, when they have been supplemented with ZH (VanOverbeke et al., 2009; Avendano-Reyes et al., 2006).

Performance and Carcass Traits of heifers treated 0, 1 or 2 or more times as well as supplemented with Zilpaterol Hydrochloride or Control

Increased number of AA decreased ($P = 0.03$) fat thickness. Carcasses from cattle with 0 AA had 1.3 cm external fat, while those with 1 AA had 1.2 cm and 2 or more AA had fat thickness of 1.1 cm. In addition, similar decreases were observed for internal fat or KPH%, as AA increased KPH% decreased ($P = 0.05$). Carcasses from cattle with 0 AA had higher ($P = 0.006$) marbling scores than carcasses from cattle with AA of 1 or more. Decrease in external and internal fat due to BRD have been previously reported by Gardner et al. (1999), Roeber et al. (2001), and Snowder et al. (2007). Also, according to existing data by McNeill et al. (1996) and Gardner et al. (1999) both reported a higher percentage of Choice carcasses from those animals not treated for BRD versus those who had been treated. Holland et al. (2010) stated that marbling score tended to decrease as the number of treatments for BRD increase. Additionally, when ZH was supplemented, there was a decrease in internal fat (1.59%, $P = 0.03$), and a decrease in yield grade for the ZH and CON heifers (Table 13). A decrease in yield grade following ZH supplementation was also shown by Montgomery et al. (2009). However, a decrease in marbling score was also found by Montgomery et al. (2009), but was not found in Phase II of the current study.

Sensory panel attributes for heifers treated 0, 1 or 2 or more times as well as supplemented with Zilpaterol Hydrochloride or Control

There were differences in tenderness (*P* = 0.01) for the number of AA as well as connective tissue (*P* = 0.01; Table 14). As number of AA increased, tenderness increased and connective tissue decreased. There were also differences for the cattle supplemented with ZH as those cattle had significantly higher WBSF scores (3.37 kg vs. 2.92 kg; *P* = 0.0002) than those who were not supplemented. Increases in WBSF of cattle fed ZH have been commonly evaluated by Pringle et al. (1993), Schroeder et al. (2003), Hilton et al. (2009), Leheska et.al. (2009) and Shook et al. (2009).

Subjective Color Evaluation of heifers treated 0, 1 or 2 or more times as well as supplemented with Zilpaterol Hydrochloride or Control

There was no difference with the cattle treated for BRD (Table 15), however there was a difference in the 156 h of surface discoloration with the cattle supplemented and not supplemented with ZH. The control group had a greater amount of surface discoloration at the 156 h than the ZH group (2.58 vs. 2.31; *P* = 0.03). Also, as with Phase I, muscle color declined, surface discoloration increased and overall acceptability decreased as time went on, however, none of these factors can be traced back to AA or the supplementation of ZH or CON.

Objective Color Evaluation of heifers treated 0, 1 or 2 or more times as well as supplemented with Zilpaterol Hydrochloride or Control

There were no differences reported for those heifers who were treated or those supplemented with ZH or who remained CON. The L* values remained similar throughout all treatments and throughout the retail display time. In addition, a* values moved away from red and became closer to green on the spectrum as surface discoloration increased. Also, b* values decreased as the display simulation continued (Table 16).

CONCLUSION

Heifers treated by VA had the lowest yield grade value and least number of AA; however, they also had the lowest carcass weight compared to the heifers treated by the other health management protocols, MT and RT. There were no sensory panel or any subjective color attribute differences for those treated by VA, MT, RT or those who were treated with AA 0, 1 or 2 or more times. There were also no difference in carcass and performance traits for those who were treated 0, 1 or 2 more times, however there was a difference for the 72 h time period for these heifers. Those administered Antimicrobials 0 or 1 time had lower a* and b* values compared to those who visited the hospital 2 or more times in Phase I.

In Phase II, those who were treated by VA had the least number of AA when compared with MT and RT. Health management did not have any other effects on the other traits measured in carcass or any sensory or color attributes. For the cattle that were treated 0, 1 or 2 times, fat thickness, internal fat and marbling all decreased as the AA increased. Additionally, the supplementation of ZH caused a decrease in internal fat and yield grade, however there was no interaction between the number of AA and the supplementation of ZH. For the sensory attributes, as AA increased so did tenderness and consequently connective tissue decreased. There was a negative effect on tenderness with the supplementation of ZH, which caused a significant increase in WBSF values. When comparing ZH to control in the simulated retail display, the control group had a greater amount of surface discoloration at the end of the shelf life display, which was 156 h. Treatment and detection of BRD is critical to the industry economically and results from this study show that different methods can be used to detect BRD without dramatically impacting carcass, sensory, and retail case life characteristics.

Table 1. Performance and carcass traits for heifers treated by visual assessment (VA), given an metaphylactic dose of Draxxin (MT) or treated based on rumen temperature (RT) Phase I, n = 127.

Trait	Treatment			SEM[1]	*P*-value[2]
	VA	MT	RT		
Hot carcass weight, kg	300.89[a]	319.42[b]	319.27[b]	12.55	0.058
Fat Thickness, cm	1.26[a]	1.80[b]	1.75[b]	0.05	0.006
Longissimus muscle area, cm^2	30.05	27.33	29.10	0.32	0.089
Internal fat (KPH), %	3.13	2.99	3.10	0.19	0.886
Yield grade	3.10[a]	4.10[b]	3.85[b]	0.18	0.003
Marbling score[3]	41.92	43.44	43.36	1.40	0.732
Antimicrobial Administrations	0.23[a]	1.02[b]	1.08[b]	0.08	0.0001

[1]Pooled SE for health management
[2]Observed significance levels for main effects of health management
[3]Marbling score: 40 = Small^{00}, 50 = Modest ^{00}
[abc] Within a row, means without a common superscript differ ($P < 0.05$)

Table 2. Trained sensory panel attributes for heifers treated by visual assessment (VA), given an metaphylactic dose of Draxxin (MT) or treated based on rumen temperature (RT), n = 125.

Trait	Treatment			SEM[1]	*P*-value[2]
	VA	MT	RT		
Initial Juiciness[3]	5.88	5.94	5.77	0.09	0.38
Sustained Juiciness[3]	5.46	5.43	5.39	0.10	0.86
Tenderness[4]	6.07	6.28	6.16	0.10	0.36
Total (Overall Impression)[4]	6.13	6.21	6.11	0.10	0.71
Connective Tissue[5]	6.75	6.85	6.86	0.11	0.79
Warner-Bratzler Shear Force, kg	3.30	3.09	3.08	0.14	0.51

[1]Pooled SE for health management
[2]Observed significance levels for main effects of health management
[3]Evaluated on an 8 point scale, 1 = Extremely dry, 8 = Extremely juicy
[4]Evaluated on an 8 point scale, 1 = Extremely tough, 8 = Extremely tender
[5]Evaluated on an 8 point scale, 1 = Abundant, 8 = None

Table 3. Trained color attributes of heifers treated by visual assessment (VA), given an metaphylactic dose of Draxxin (MT) or treated based on rumen temperature (RT), Phase I, n = 125.

Trait	Treatment			SEM[1]	*P*-value[2]
	VA	MT	RT		
Muscle Color[3]					
0 h	6.31	6.33	6.31	0.09	0.96
72 h	5.77	5.78	5.79	0.04	0.88
156 h	4.36	4.24	4.31	0.13	0.63
Surface Discoloration[4]					
0 h	-	-	-	-	-
72 h	1.14	1.12	1.13	0.05	0.90
156 h	2.71	2.88	2.86	0.22	0.66
Overall Appearance[5]					
0 h	7.62	7.54	7.52	0.10	0.59
72 h	6.16	6.23	6.25	0.09	0.59
156 h	2.81	2.71	2.72	0.21	0.86

[1]Pooled SE for health management
[2]Significance value of $P < 0.05$
[3] 8 point scale; 8 = extremely bright cherry red, 1 = extremely dark red
[4] 7 point scale; 7 = total discoloration, 1 = no discoloration
[5] 8 point scale; 8 = extremely desirable, 1 = extremely undesirable

Table 4. L*,a,* and b* values of heifers treated by visual assessment (VA), given an metaphylactic dose of Draxxin (MT) or treated based on rumen temperature (RT), Phase I, n = 125.

Trait	Treatment			SEM[1]	*P*-value[2]
	VA	MT	RT		
Hour 0					
L*[5]	40.67	40.29	40.69	0.32	0.60
a*[6]	24.69	24.74	24.53	0.24	0.80
b*[7]	21.07	21.08	21.15	0.20	0.95
Hour 72					
L*	40.39	40.05	40.69	0.35	0.43
a*	22.11	21.60	21.42	0.31	0.27
b*	19.72	19.27	19.48	0.21	0.32
Hour 156					
L*	40.21	40.03	40.83	0.42	0.39
a*	17.23	16.22	16.01	0.60	0.32
b*	17.24	16.72	17.02	0.29	0.42

[1] Pooled SE for health management
[2] Observed significance levels for main effects of health management
[3] Pooled SE of treatment of Zilpaterol and Control
[4] Observed significance levels for Zilpaterol and Control
[5]L* values, 0 = black, 100 = white
[6]a* values, Positive a* = red, Negative a* = green
[7]b* values, Positive b* = yellow, Negative b* = blue

Table 5. Performance and carcass traits for heifers based on antimicrobial administrations for bovine Phase I, n = 127.

Trait	Antimicrobial administrations[1]			SEM[2]	P-value[3]
	0	1	2+		
Hot carcass weight, kg	316.7	308.8	316.4	11.34	0.33
Fat Thickness, cm	1.60	1.60	1.60	0.04	0.93
Longissimus muscle area, cm^2	29.50	28.50	29.60	0.29	0.41
Internal fat (KPH), %	3.15	2.93	3.07	0.17	0.48
Yield grade	3.60	3.70	3.60	0.18	0.95
Marbling score[4]	44.43	43.57	40.34	1.24	0.16

[1] Metaphylactic administration of Draxxin was counted as 1 antimicrobial administration
[2] Pooled SE for antimicrobial administrations
[3] Observed significance levels for main effects of antimicrobial administrations
[4] Marbling score: 40 = $Small^{00}$, 50 = $Modest^{00}$

Table 6. Trained sensory panel attributes for heifers treated or not treated for respiratory disease, Phase I, n = 125.

Trait	Antimicrobial administrations[1]			SEM[2]	*P*-value[3]
	0	1	2+		
Initial Juiciness[4]	5.80	5.85	5.89	0.09	0.82
Sustained Juiciness[4]	5.45	5.36	5.45	0.10	0.62
Tenderness[5]	6.11	6.11	6.26	0.09	0.55
Total (Overall Impression)[5]	6.08	6.09	6.25	0.09	0.52
Connective Tissue[6]	6.84	6.65	6.97	0.10	0.09
Warner-Bratzler Shear Force,kg	3.11	3.23	3.11	0.13	0.63

[1]Metaphylactic administration of Draxxin was counted as 1 antimicrobial administration

[2]Pooled SE for antimicrobial administrations

[3]Observed significance levels for main effects of antimicrobial administrations

[4]Evaluated on an 8 point scale, 1 = Extremely dry, 8 = Extremely juicy

[5]Evaluated on an 8 point scale, 1 = Extremely tough, 8 = Extremely tender

[6]Evaluated on an 8 point scale, 1 = Abundant, 8 = None

Table 7. Trained color panelists of heifers treated or not treated for respiratory disease, Phase I, n = 125.

Trait	Antimicrobial administrations[1]			SEM[2]	*P*-value[3]
	0	1	2+		
Muscle Color[4]					
0 h	6.29	6.33	6.36	0.07	0.82
72 h	5.79	5.77	5.79	0.03	0.82
156 h	4.32	4.27	4.36	0.10	0.83
Surface Discoloration[5]					
0 h					
72 h	1.13	1.14	1.10	0.04	0.69
156 h	2.73	2.87	2.84	0.17	0.76
Overall Appearance[6]					
0 h	7.59	7.55	7.53	0.08	0.88
72 h	6.24	6.20	6.22	0.07	0.88
156 h	2.76	2.74	2.79	0.17	0.98

[1] Metaphylactic administration of Draxxin was counted as 1 antimicrobial administration
[2] Pooled SE for antimicrobial administrations
[3] Significance value of $P < 0.05$
[4] 8 point scale; 8=extremely bright cherry red, 1=extremely dark red
[5] 7 point scale; 7=total discoloration, 1=no discoloration
[6] 8 point scale; 8=extremely desirable, 1=extremely undesirable

Table 8. L*,a,* and b* values of heifers treated and not treated for respiratory disease, Phase I, n = 125.

Trait	Antimicrobial administrations[1]			SEM[2]	*P*-value[3]
	0	1	2+		
Hour 0					
L*[4]	40.80	40.30	40.89	0.36	0.37
a*[5]	24.69	24.70	24.40	0.27	0.76
b*[6]	21.16	21.08	21.00	0.22	0.90
Hour 72					
L*	40.42	40.26	40.58	0.40	0.85
a*	21.95	21.37	22.57	0.35	0.06
b*	19.61[a]	19.25[a]	20.15[b]	0.24	0.04
Hour 156					
L*	40.60	40.03	40.94	0.49	0.38
a*	17.16	16.27	15.75	0.69	0.37
b*	17.21	16.85	16.95	0.34	0.63

[1] Metaphylactic administration of Draxxin was counted as 1 antimicrobial administration
[2] Pooled SE for antimicrobial administrations
[3] Observed significance levels for main effects of antimicrobial administrations
[4] L* values, 0 = black, 100 = white
[5] a* values, Positive a* = red, Negative a* = green
[6] b* values, Positive b* = yellow, Negative b* = blue
[ab] Within a row, means without a common superscript differ ($P < 0.05$)

Table 9. Performance and carcass traits for heifers treated by visual assessment (VA), given an metaphylactic dose of Draxxin (MT) or treated based on rumen temperature (RT) and also supplemented with Zilpaterol Hydrochloride (ZH) or Control, Phase II, n = 155.

Trait	Treatment			SEM[1]	*P*-value[2]	CON	ZH	SEM[3]	*P*-value[4]
	VA	MT	RT						
Hot carcass weight,kg	316.54	312.34	315.30	5.70	0.67	312.30	318.10	6.36	0.14
Fat thickness, cm	1.18	1.18	1.15	0.04	0.93	1.20	1.10	0.24	0.08
Longissimus muscle area,cm^2	32.38	32.90	29.11	0.81	0.78	31.40	33.70	0.19	0.49
Internal Fat(KPH), %	1.59	1.63	1.63	0.64	0.80	1.68[a]	1.59[b]	0.04	0.03
Yield Grade	2.51	2.46	2.53	0.19	0.92	2.70[a]	2.30[b]	0.11	0.01
Marbling Score[5]	43.71	41.08	41.31	1.70	0.31	43.90	41.89	1.10	0.19
Antimicrobial administrations	0.85[a]	1.35[b]	1.29[b]	0.13	0.0004	1.23	1.12	0.08	0.32

[1] Pooled SE for health management

[2] Observed significance levels for main effects of health management

[3] Pooled SE of treatment of Zilpaterol and Control

[4] Observed significance levels for Zilpaterol and Control

[5] Marbling score: 40 = Small ^{00}, 50 = Moderate ^{00}

[ab] Within a row, means without a common superscript differ ($P < 0.05$)

Table 10. Trained sensory panel attributes for heifers treated by visual assessment (VA), given a metaphylactic dose of Draxxin (MT) or treated based on rumen temperature (RT) and also supplemented with Zilpaterol Hydrochloride (ZH) or Control, Phase II, n=143.

Trait	Treatment			SEM[1]	P-value[2]	CON	ZH	SEM[3]	*P*-value[4]
	VA	MT	RT						
Initial Juiciness[5]	5.99	6.00	5.93	0.07	0.50	5.97	5.98	0.04	0.81
Sustained Juiciness[5]	5.44	5.42	5.48	0.08	0.80	5.43	5.45	0.10	0.79
Tenderness[6]	6.25	6.21	6.15	0.09	0.60	6.22	6.20	0.06	0.72
Tenderness (Overall Acceptability)[6]	6.04	6.06	6.01	0.09	0.86	6.03	6.04	0.05	0.84
Connective Tissue[7]	6.71	6.80	6.88	0.15	0.52	6.63	6.82	0.09	0.12
Warner-Bratzler Shear Force,kg	3.08	3.23	3.14	0.12	0.46	2.92[b]	3.37[a]	0.07	0.0002

[1] Pooled SE for health management

[2] Observed significance levels for main effects of health management

[3] Pooled SE of treatment of Zilpaterol and Control

[4] Observed significance levels for Zilpaterol and Control

[5] Evaluated on an 8 point scale, 1 = extremely dry, 8 = extremely juicy

[6] Evaluated on an 8 point scale, 1 = extremely tough, 8 = extremely tender

[7] Evaluated on an 8 point scale, 1 = abundant, 8 = none

[ab] Within a row, means without a common superscript differ ($P < 0.05$)

Table 11. Trained color panelists of heifers treated by visual assessment (VA), given a metaphylactic dose of Draxxin (MT) or treated based on rumen temperature (RT) and also supplemented with Zilpaterol Hydrochloride (ZH) or Control, Phase II, n = 143.

Trait	Treatment			SEM[1]	*P*-value[2]	CON	ZH	SEM[3]	*P*-value[4]
	VA	MT	RT						
Muscle Color[5]									
0 h	6.53	6.45	6.48	0.09	0.67	6.50	6.50	0.05	0.96
72 h	5.22	5.21	5.21	0.06	0.99	5.22	5.20	0.04	0.85
156 h	3.65	3.68	3.69	0.11	0.94	3.72	3.67	0.08	0.49
Surface Discoloration[6]									
0 h	1.03	1.04	1.04	0.02	0.84	1.03	1.03	0.009	0.89
72 h	1.08	1.10	1.09	0.03	0.77	1.07	1.08	0.19	0.74
156 h	2.51	2.49	2.45	0.16	0.93	2.58[a]	2.31[b]	0.09	0.03
Overall Appearance[7]									
0 h	7.20	7.18	7.17	0.05	0.90	7.19	7.15	0.02	0.34
72 h	5.76	5.68	5.72	0.12	0.84	5.74	5.34	0.07	0.30
156 h	2.59	2.65	2.73	0.17	0.69	2.66	2.75	0.10	0.54

[1] Pooled SE for health management
[2] Observed significance levels for main effects of health management
[3] Pooled SE of ZH supplementation and CON
[4] Observed significance levels for ZH and CON
[5] 8 point scale; 8 = extremely bright cherry red, 1 = extremely dark red
[6] 7 point scale; 7 = total discoloration, 1 = no discoloration
[7] 8 point scale; 8 = extremely desirable, 1 = extremely undesirable
[ab] Within a row, means without a common superscript differ ($P < 0.05$)

Table 12. L*,a* and b* values of heifers treated by visual assessment (VA), given an metaphylactic dose of Draxxin (MT) or treated based on rumen temperature (RT) as well as supplemented with Zilpaterol Hydrochloride (ZH) or Control, n = 143.

Trait	Antimicrobial administrations			SEM[1]	*P*-value[2]	CON	ZH	SEM[3]	*P*-value[4]
	VA	MT	RT						
Hour 0									
L*[5]	43.01	42.88	43.22	0.44	0.86	42.97	43.24	0.37	0.59
a*[6]	24.47	24.43	24.01	0.24	0.34	24.17	24.37	0.21	0.47
b*[7]	21.05	21.03	20.54	0.22	0.19	20.70	21.04	0.19	0.19
Hour 72									
L*	42.61	42.20	42.25	0.42	0.77	42.28	42.43	0.36	0.46
a*	20.82	20.88	20.89	0.27	0.98	20.91	20.84	0.23	0.82
b*	18.89	18.89	18.87	0.19	0.99	18.79	19.04	0.14	0.11
Hour 156									
L*	43.75	43.67	43.52	0.46	0.94	43.61	43.92	0.39	0.56
a*	18.16	18.81	18.99	0.47	0.43	18.88	18.65	0.40	0.66
b*	16.72	17.15	17.45	0.24	0.11	17.16	17.12	0.21	0.88

[1] Pooled SE for health management

[2] Observed significance levels for main effects of health management

[3] Pooled SE of treatment of Zilpaterol and Control

[4] Observed significance levels for Zilpaterol and Control

[5] L* values, 0 = black, 100 = white

[6] a* values, Positive a* = red, Negative a* = green

[7] b* values, Positive b* = yellow, Negative b* = blue

Table 13. Performance and carcass traits for heifers treated or not treated for respiratory disease as well as supplemented with Zilpaterol Hydrochloride (ZH) or Control, n = 155.

Trait	Antimicrobial administration			SEM[1]	P-value[2]
	0	1	2+		
Hot carcass weight,kg	317.40	317.10	311.20	0.14	0.35
Fat thickness, cm	1.30[a]	1.20[b]	1.10[c]	0.014	0.03
Longissimus muscle area,cm^2	31.90	33.00	32.90	0.0005	0.24
Internal Fat (KPH), %	1.70[a]	1.60[b]	1.50[c]	0.083	0.05
Yield Grade	2.90	2.50	2.20	0.0078	0.13
Marbling Score[3]	46.97[a]	41.45[b]	40.25[b]	0.19	0.0055

[1] Pooled SE for antimicrobial administrations

[2] Observed significance levels for main effects of antimicrobial administrations

[3] Marbling score: 40 = Small [00], 50 = Moderate [00]

[abc] Within a row, means without a common superscript differ ($P < 0.05$)

Table 14. Trained sensory panel attributes for heifers treated or not treated for respiratory disease as well as supplemented with Zilpaterol Hydrochloride (ZH) or Control, n = 143.

Trait	Antimicrobial administrations			SEM[1]	P-value[2]
	0	1	2+		
Initial Juiciness[3]	5.97	5.93	6.03	0.05	0.29
Sustained Juiciness[3]	5.39	5.41	5.53	0.06	0.27
Tenderness[4]	6.13[b]	6.11[b]	6.38[a]	0.07	0.01
Tenderness (Overall Acceptability)[4]	5.95	5.99	6.17	0.07	0.06
Connective Tissue[5]	6.40[c]	6.85[b]	6.93[a]	0.11	0.01
Warner-Bratzler Shear Force,kg	3.01	3.26	3.16	0.09	0.18

[1] Pooled SE for antimicrobial administrations

[2] Observed significance levels for main effects of antimicrobial administrations

[3] Evaluated on an 8 point scale, 1= extremely dry, 8 = extremely juicy

[4] Evaluated on an 8 point scale, 1= extremely tough, 8 = extremely tender

[5] Evaluated on an 8 point scale, 1= abundant, 8 = none

[abc]Within a row, means without a common superscript differ ($P < 0.05$)

Table 15. Trained color panelists of heifers treated or not treated for respiratory disease as well as supplemented with Zilpaterol Hydrochloride (ZH) or Control, Phase II, n = 143.

Trait	Antimicrobial administration			SEM[1]	*P*-value[2]
	0	1	2+		
Muscle Color[3]					
0 h	6.50	6.49	6.52	0.06	0.91
72 h	5.20	5.20	5.23	0.04	0.86
156 h	3.77	3.67	3.64	0.06	0.62
Surface Discoloration[4]					
0 h	1.01	1.05	1.03	0.12	0.13
72 h	1.04	1.10	1.09	0.02	0.17
156 h	2.22	2.49	2.63	0.12	0.09
Overall Appearance[5]					
0 h	7.11	7.19	7.20	0.04	0.30
72 h	5.61	5.71	5.74	0.92	0.62
156 h	2.93	2.60	2.60	0.13	0.19

[1] Pooled SE for antimicrobial administrations

[2] Observed significance levels for main effects of antimicrobial administrations

[3] 8 point scale; 8 = extremely bright cherry red, 1 = extremely dark red

[4] 7 point scale; 7 = total discoloration, 1 = no discoloration

[5] 8 point scale; 8 = extremely desirable, 1 = extremely undesirable

Table 16. L*,a* and b* values of heifers treated and not treated for respiratory disease as well as supplemented with Zilpaterol Hydrochloride (ZH) or Control, Phase II, n = 143.

Trait	Antimicrobial administrations			SEM[1]	*P*-value[2]
	0	1	2+		
Hour 0					
L*[3]	43.54	43.09	42.67	0.46	0.49
a*[4]	24.20	24.26	24.37	0.26	0.90
b*[5]	21.01	20.76	20.84	0.24	0.78
Hour 72					
L*	42.59	42.47	41.64	0.44	0.14
a*	20.75	20.78	21.10	0.28	0.66
b*	19.08	18.94	18.71	0.17	0.22
Hour 156					
L*	44.41	43.60	43.29	0.49	0.36
a*	18.78	18.65	18.89	0.49	0.92
b*	17.01	17.13	17.29	0.26	0.78

[1] Pooled SE for Antimicrobial administrations

[2] Observed significance levels for main effects of Antimicrobial administrations

[3] L* values, 0 = black, 100 = white

[4] a* values, Positive a* = red, Negative a* = green

[5] b* values, Positive b* = yellow, Negative b* = blue

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Pages in Study: 54 Candidate for the Degree of Master of Science

Major Field: Animal Science

Scope and Method of Study: In Phase I the importance was to understand the impact of treatment on the meat products. The objectives of this study were to study health management treatments either by visual assessment, being given a metaphylactic dosage of Draxxin or rumen temperature. Cattle were treated either 0, 1 or 2 or more times, however, the group that was treated 1 time was mostly comprised of those given an metaphylactic dosage of Draxxin. The effects of these health monitoring and treatments and their effects on carcass, color and palatability traits were studied. In Phase II, the impact of zilpaterol hydrochloride supplementation was added in addition to the health management and treatments. Carcass, color and palatability traits were also studied. A total of 268 strip loins were collected and 3 steaks were cut from each loin. One each for sensory panel, WBSF and simulated retail display.

Findings and Conclusions: In Phase I, heifers treated by VA had the lowest yield grade value, lowest carcass weight and the least number of Antimicrobial administrations compared to the other health management protocols, UD and RT. No differences were found for sensory panel or subjective color attributes for any treatment groups. Additionally, there were no differences in carcass and performance traits for those treated 0, 1 or 2 or more times. In phase II, VA treated heifers had the least number of PA compared to UD and RT. Health management did not have an effect on any other traits measured in carcass, sensory or color attributes. Cattle who were treated 0, 1 or 2 or more times, fat thickness, internal fat and marbling all decreased as PA increased. Supplementation of ZH caused a decrease in internal fat and yield grade value, however, there was no interaction between the number of PA and ZH supplementation. For sensory attributes, as PA increased so did tenderness and connective tissue decreased. ZH supplementation also caused an increase in WBSF and when comparing ZH to CON, CON had a greater amount of surface discoloration. Treatment and detection of BRD and this study shows that different methods can be used with out impacting carcass, sensory and retail case life.

ADVISER'S APPROVAL: Gretchen Hilton