EFFECTS OF DAYS ON FEED AND MAGNESIUM MICA ON PERFORMANCE AND CARCASS CHARACTERISTICS OF FEEDLOT STEERS

By

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Bachelor of Science

Mississippi State University

Starkville, Mississippi

1996

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
July, 1999

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MICA ON PERFORMANCE AND CARCASS

CHARACTERISTICS OF

FEEDLOT STEERS

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ACKNOWLEDGMENTS

At this juncture in my educational endeavors, I would like to express my sincere appreciation to the individuals who have provided me with excellent opportunities. I would first like to thank Dr. Don Gill for allowing me to pursue a graduate degree under his supervision. The opportunities for education and their challenges presented by Dr. Don Gill have been innumerable and are greatly appreciated. I would also like to thank Dr. Fred Owens for the instruction and inspiration he has provided. To Dr. H. G. Dolezal, the insight and encouragement provided is greatly appreciated.

Extreme gratitude is expressed toward my fellow graduate students for their companionship, encouragement and assistance during my time at Oklahoma State University. Sincere thanks is extended to Brett Gardner and Zeb Prawl for their assistance and input regarding research and the many other facets of my education and life. Appreciation is also extended to Bilynn Schutte and Steven Cooper for their friendship and added assistance during my graduate pursuits.

Special appreciation is extended to Morton Meats for providing cattle for the present study. Also, thanks is expressed to Dr. Jerry Martin and all involved personnel at Panhandle State University for the care and feeding during the trial.

Dr. C. A. Strasia also played a key role in conducting this research and I am grateful for all of his assistance and advice. I would like to thank Brookover Companies for their cooperation and production of feed for the study.

The most sincere gratitude is expressed to my family, Sidney, Lynn and Leanne, in appreciation for their encouragement and support in everything I have pursued. Your confidence in me and all of your support has provided me with unending opportunity to attain any goals which I have placed in front of myself. This would have never been possible without your assistance.

To Jill, my wife, thank you for your support and patience during this endeavor which has been very trying at times. You have made the entire experience worthwhile and possible. I would also like to thank you for understanding the difficult hours and days. You have been a great inspiration which urges me to strive for the best for our future.

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CHAPTER 1

INTRODUCTION

American consumers associate greater eating satisfaction with beef from cattle fed high concentrate diets than from cattle fattened on grass. Several studies indicate that a minimum of 90-100 days of high concentrate feeding will improve the probability that consumers have a desirable eating experience. These increases in consumer satisfaction are due to increases in tenderness and the flavor attributes to which consumers are accustomed. Also, USDA quality grades tend to increase with time on feed, so carcass value will be increased when sold on a quality grade basis. However, feeding cattle beyond the minimal days necessary to achieve a satisfactory eating experience typically results in carcasses that are fatter. These increases in carcass fat typically result in less desirable yield grades; these higher yield grades warrant discounts from the packer and will decrease returns when cattle are sold on a yield basis.

When cattle are fed beyond optimal periods, feed efficiency generally deteriorates because the proportion of lean to fat tissue deposition decreases. Lean tissue is more expensive to maintain but fat is deposited with lower weight/weight efficiency than lean tissue and results in depressed weight gains and increased feed to gain ratios. Since feed efficiency is generally one of the most important contributors to the profitability of a cattle feeding operation, feeding cattle for longer than needed is likely to decrease profit.

Magnesium, an essential nutrient for all animals, is involved in many metabolic processes. Magnesium is a necessary ion in enzymatic reactions involved with intermediary metabolism and allows for the utilization of energy. Protein synthesis and neuromuscular transmission are also dependent upon Mg. The primary site of Mg absorption in ruminants is the rumeno-reticulum with excess Mg being excreted through the urine. Endogenous losses and unabsorbed Mg is excreted through the feces. The largest stores of Mg are found in the skeleton. Many sources of Mg are capable of meeting the needs of the animal. Some commercial sources are Mg oxide, Mg sulfate, and Mg mica. Potential uses of Mg mica, a mined silicate, in animal production have been investigated. Magnesium mica's primary use has traditionally been as an additive to promote pellet binding and to increase production rates in the pelletting process of feed manufacturing.

CHAPTER II

REVIEW OF THE LITERATURE

Effect of Days on Feed

Live Performance. Zinn et al. (1970a) reported that average daily gain (ADG) increased significantly with days on feed until day 120, thereafter, increases were not significant through 180 days. Van Koevering et al. (1995) observed a linear tendency for increased ADG with increased days on feed. However, in a serial harvest reported by May et al. (1992), no differences in ADG, except for the group harvested at 28 days on feed, were observed. The explanation offered for the increased ADG was that compensatory gain was experienced after initial placement onto a concentrate diet. In contrast to these increases, Thonney et al. (1981) reported that for every 100 lb. increase in body weight, average daily gain decreased by .18 lb.

Thonney et al. (1981) also reported that dry matter intake per lb. of live weight gain increased by 2.2 lb. for every 100 lb. increase in body weight. Others (Fahmy and Lalande, 1975; Hicks et al., 1987) also have reported that efficiency of feed use decreases with increasing slaughter weight. Conversely, Van Koevering et al. (1995) observed that feed efficiency, on a carcass basis, tended to be most desirable for steers fed 119 days when compared to those fed shorter or longer time periods (105, 133, or 147 days).

Carcass Measurements. As time on feed increases, live weight, carcass weight, dressing percentage, fat thickness, marbling score and overall carcass maturity generally increase (McKeith et al., 1985; Dolezal et al., 1982; Tatum et al., 1980; May et al., 1992). Heifers tended to have lower ADG and required 30 to 60 more days on feed than steers to reach any given USDA quality grade even though intramuscular fat was deposited at a rate similar to that of steers (Zinn et al., 1970a). With increased weight at slaughter, the percentage of certain cuts such as the round and shank decreased while the percentage of more expensive cuts of the rib and flank increased (Fahmy and Lalande, 1975), so carcass value may be increasing with slaughter weight.

Tenderness and Palatibility. Zinn et al. (1970b) harvested calf-fed steers at 30 day intervals and reported that as time on feed increased, Warner Bratzler shear force decreased significantly through 180 days on feed. However, after 180 days, shear force increased significantly through day 270 causing the response to be curvilinear. They suggested that chronological aging was responsible for the decrease in tenderness after 180 days. Epley et al. (1968) observed a similar decrease in Warner Bratzler shear force through 139 days on feed. Dolezal et al. (1982) reported that taste panel tenderness improved and shear force decreased after steers had been fed grain for 100 days or longer. In support, May et al. (1992) reported similar results, but in his trial, 84 days on feed appeared to be the minimum for desirable improvements in tenderness. In contrast, Aalhus et al. (1992) found that when time on feed was limited to 143 days on a 75-80% concentrate ration, and neither electrical stimulation nor aging were used, consumers rated 40% of steaks unacceptable for tenderness. McKeith et al. (1985) reported that the of effect days on feed on shear force was greater for Brahman steers than Angus steers.

Wu et al (1981) reported that the longissimus muscle from steers fed high energy diets had a higher percentage of salt soluble collagen as compared to the same muscle from grass-fed steers. Collagen that is salt soluble represents recently synthesized collagen. Higher collagen solubility and subsequent increases in tenderness have also been associated with higher rates of weight gain prior to slaughter for mature cows (Miller et al., 1987). These increases in solubility of collagen were due to increases in collagen biosynthesis and/or a decreased rate of collagen crosslinking.

Flavor desirability was highest for steer beef fed for 130 days or longer (Tatum et al., 1980; Dolezal et al., 1982). Increasing time on feed resulted in significant improvement in juiciness and overall palatibility when evaluated by consumers (Aalhus et al., 1992).

Carcasses from longer fed cattle had significantly lower pH at 24h postmortem and less cooler shrink than short fed, leaner carcasses (Aalhus et al., 1992). Increased backfat thickness and its insulation properties are presumed to have moderated postmortem chilling rates of carcasses from longer fed cattle and this resulted in lower pH values. In further support of this idea, May et al. (1992) concluded that trimming subcutaneous fat from one side of the carcass prior to chilling resulted in an increased 24 hour pH. The trimmed sides subsequently were less tender than control sides. They suggested that the higher 2.5 h postmortem temperature allowed for greater intrinsic tenderization.

Magnesium

Roles in the Body. The primary intracellular divalent cation, Mg, is involved with numerous enzymes (Shils, 1958). These enzymes, and their reactions, are essential in intermediary metabolism and utilization of ATP. Magnesium is involved in glucose phosphorylation during anaerobic metabolism, fatty acid oxidation, hydrolysis of phosphatases and pyrophosphatases, and activation of amino acids. Magnesium is involved in protein synthesis as well as the synthesis and degradation of DNA. Magnesium facilitates the formation of cyclic adenosine monophosphate (cAMP) and other secondary messengers. Also, neuromuscular transmission and activity is dependent upon Mg.

Extracellular fluid contributes significantly to magnesium in the saliva (Dua and Cure, 1995). Other losses of Mg from extracellular fluid occur as a result of bone formation and cellular growth (Fontenot et al., 1989). Losses due to bone formation are suggested to be significant only in rapidly growing ruminants. Some Mg secreted in saliva is reabsorbed, while the rest is lost as endogenous fecal excretion (Dua and Cure, 1995). Endogenous fecal losses also occur from other digestive secretions and to some extent from desquamated epithelial cells (Rook and Storry, 1962).

The Mg content of cow's milk averages about 12 mg per 100 ml and varies little except for colostrum, which has a high concentration, but decreases rapidly within a few hours to a relatively constant level (Rook and Storry, 1962). Mg content of milk is not affected by ambient temperature, feed intake, stage of lactation, dietary Mg, onset of hypomagnesemia, or milk yield.

Magnesium is found in the animal body at about .05% of body weight, of which 60% is found in the skeleton, forty percent in soft tissue cells and about one percent in the extracellular fluid (Rook and Storry, 1962). Over 30% of skeletal Mg may be mobilized during Mg deprivation in the young, growing ruminant. This Mg may be used for soft tissue growth and other processes but is also incorporated into newly synthesized bone, which is low in Mg and rich in calcium. Mature ruminants do not have this capability to mobilize Mg from bone, as only about 2% of the skeletal Mg is available for resorption.

Absorption. Magnesium absorption occurs primarily in the reticulo-rumen with absorption in the omasum and abomasum being minimal (Dua and Cure, 1995; Tomas and Potter, 1976). An active Na-linked transport mechanism is used to facilitate the movement of Mg across the ruminal mucosa (Fontenot et al., 1989). Field and Munro (1977) found when Mg was infused at various sites, the rumen was the main site of absorption in sheep. Small amounts were absorbed from the omasum and none was absorbed from the abomasum. When infused with similar concentrations of Mg, ruminal absorption was greater than duodenal absorption. However, absorption decreased when sheep were fed a hay diet, indicating that diet constituents may affect absorption. When excess Mg is absorbed, the primarily route of excretion is in the urine (NRC, 1996).

Giduck and Fontenot (1984) observed that magnesium absorption increased with glucose infusion. Readily available carbohydrates increased Mg absorption although this was not due to alterations in ruminal pH or the change in fermentation patterns and no explanation was offered. Zinn et al. (1996) reported that ruminal starch digestion decreased with increasing Mg, but failed to offer an explanation for this interaction.

Zinn et al. (1996) also reported that as dietary Mg increased, absorption decreased. Laidlomycin propionate also decreased Mg absorption. However, Greene et al. (1988) reported that Mg absorption was increased with monensin supplementation.

Greene et al. (1989) illustrated that Mg absorption is greater for Brahman cows than Jersey, Holstein or Hereford cows. Mg concentrations of Angus cows were shown to be similar to Brahman and greater than Hereford cattle. However, Angus and Hereford cattle are more prone to hyopmagnesemia than Brahman cattle under similar production environments. Absorption patterns for different breeds may partially explain the greater incidence of grass tetany in Hereford and Angus cows as compared to Brahman cows. Differences between the breeds in digestive and metabolic functions, as well as milk production, have been suggested as the explanation for their differing propensities for hypomagnesemia.

Potassium and Mg interactions have been studied extensively. Greene et al. (1983) concluded that dietary K did not alter the site of Mg absorption. However, increasing K to 2.4 and 4.8% of the diet depressed Mg absorption by 67 and 82%, respectively. Consequently, serum Mg concentrations were decreased. The primary effect of K intake has on Mg absorption is a reduction in preintestinal absorption in both cattle and sheep (Greene et al., 1983). Low amounts of Mg were absorbed from the rumen when high levels of K were fed, but compensatory absorption occurred distal to the rumen (Dalley et al., 1997). However, the total amount of Mg absorbed decreased despite increased post ruminal absorption. The decreased ruminal absorption occurred in association with small increases in ruminal pH and subsequently lower Mg concentrations in the liquid phase of the digesta.

Low dietary Na concentrations result in an increased K concentration and decreased Na concentration in saliva and ruminal fluid (Bailey, 1961; Martens et al., 1987). Decreased net absorption of Mg from the forestomachs due to low Na and high K concentrations in ruminal fluid and a high potential difference across the rumen epithelium was reported by Tomas and Potter (1976) and Greene et al. (1983). Consequently, the decreased Mg absorption due to increased K intake is likely one of the factors contributing to the occurrence of grass tetany. Sodium content of lush spring forage usually does not meet the animals requirements and, in combination with high K fertilization rates of lush forage, would be expected to contribute to the onset of hypomagnesemia in grazing ruminants. The rapid transition from a winter diet to lush spring forage results in a reduction of Na pool size and decreased Mg absorption (Martens et al., 1987). The onset of hypomagnesemia is likely due to decreased Mg absorption and low Mg concentration of the spring forage and a combination of the other factors discussed.

Stillings et al. (1964) reported, from three experiments, that Mg availability was 18 to 24% when sheep consumed forages which contained low amounts of N (2.11-2.62%). When forages contained high amounts of N (3.74-4.38%), Mg availability was estimated to be 11 to 16%. Mg retention was lower for the high N forages despite the fact that these forages had significantly higher Mg content. Blaxter and McGill (1956) concluded that the average availability of Mg from a complete ration without mineral supplementation was 33%. Stillings et al. (1964) observed that the consumption of 2000 IU of vitamin D_2 per day resulted in a significant increase in availability and retention of Mg from the low N forages. However, when animals receiving the high N diet were supplemented with vitamin D_2, Mg retention was decreased while apparent availability was not effected.

Sources. NRC (1996) suggests that dietary Mg requirements for growing finishing, gestating and lactating cattle are .10, .12 and .20%, respectively, on a dry matter basis. Magnesium oxide is an often used source of Mg due to its high Mg content (53.9%) and its rumen buffering capacity. The primary excretion of

Mg absorbed in excess of requirement is through the urine. When observing urinary response, Jackson et al. (1989) found that MgO and $MgSO_4$ were more readily available sources of Mg than Mg mica. It was concluded that Mg mica may sediment in the floor of the rumen and suggest a higher efficiency. The Mg mica treatment had the highest Mg intake and the highest fecal Mg excretion. Plasma Mg concentration was highest for MgO and $MgSO_4$ while the Mg mica group was only slightly higher than control animals. Magnesium mica had the highest Mg retention while being intermediate in apparent digestibility. Efficiency values indicate that Mg mica is a superior Mg source. However, little Mg was excreted in the urine of Mg mica animals. The Mg mica sedimentation in the rumen was the likely reason for the appearance of higher retention and efficiency.

Deficiency. Grass tetany or hypomagnesemic tetany occurs primarily in lactating cows grazing lush spring pasture or forages low in Mg and is characterized by low Mg concentrations in plasma and cerebrospinal fluid (NRC, 1996). Symptoms include nervousness, reduced feed intake, muscular twitching around the face and ears, and an uncoordinated and stiff gait. In advanced stages of the deficiency, cows will be found on their side with their head back and convulsing. Death soon follows if treatment is not immediate.

Grass tetany may be predisposed by high fertilization rates with N and K as typically occurs in the spring. The typically low Mg content of lush spring forage, in combination with the high K content and their subsequent interactions, appears to be one of the primary factors contributing to hypomagnesemia. The typically low Na content of lush forage appears to also contribute to the occurrence. Also, the in vitro Mg flux in and out of the cell is greatly affected by anoxia, hypothermia and acidosis (Brautbar et al., 1982). Moreover, when the ambient temperature is between 8° and 14°C, clinical cases of hypomagnesemia are more frequent (Rook and Storry, 1962). High endogenous fecal losses, resulting from Mg content of saliva, may be associated with high roughage and fresh grass diets and contribute to the onset of hypomagnesemia.

Toxicity. When steers were fed Mg at 2.4 and 3.7% of the diet, severe diarrhea and lethargic activity were observed (Chester-Jones et al., 1990). Dry matter digestibility and fecal dry matter were also decreased. Increasing Mg caused progressive degeneration of the stratified squamous epithelium of rumen papillae. However, rectal temperatures were considered normal and ranged from 38 to 39.5°C. Magnesium absorption increased with increased intake whereas apparent P and Ca absorption decreased. In contrast, Zinn et al. (1996) compared dietary Mg concentrations of .18 and .32% and found that as dietary Mg increased, absorption decreased. It should be considered that the diets fed by Chester-Jones et al. (1990) contained 41.6% grain while those fed by Zinn et al. (1996) contained 77.45% grain.

Magnesium Mica. Magnesium mica is a mined silicate, which contains primarily magnesium, iron, and potassium, but other minerals are also found in trace amounts (see Table 3 for complete analysis). Some possible roles of Mg mica in the feed industry have been investigated through many trials. However, the primary utilization of Mg mica is as a pellet binder. Magnesium mica was shown by Sharp et al. (1993) to improve pellet quality and production rate of a 20% protein range cube. Increases in production rate of one half ton per hour for each 1% increase in Mg mica were observed.

Coffey and Brazle (1996) reported that Mg mica supplementation decreased cost of gain by $3.00 per cwt. for feedlot steers. The addition of Mg mica diluted ration cost to facilitate the reduction in cost of gain. However, the ration dilution did not impact feed efficiency. Magnesium mica fed steers averaged one third of a quality grade higher than control steers. However, no obvious explanation is available for the improvements observed in quality grade. Magnesium mica had no effect on feedlot gain, consumption, efficiency, carcass weight or fat thickness.

Coffey et al. (1996) observed that when steers were supplemented with Mg mica while grazing pasture, subsequent carcass weights and dressing percentages were higher than control steers, following the feedlot finishing phase. The carcasses from the group receiving supplemental Mg mica during the pasture phase had 50% more U.S. Choice carcasses than control steers. Coffey then suggested that Mg mica supplemented at a rate of 9-10 pounds per ton of dry matter should have no significant effects on gain and efficiency of feedlot steers. This also suggests that if a supplement containing Mg mica is provided while grazing pasture, marbling scores after a normal finishing period may be increased.

Maxwell et al. (unpublished) reported that, when Mg mica was included at rates of 1.25 and 2.5% of growing-finishing swine rations, cost of gain was reduced by $0.57 and $0.33 per cwt. gain as compared to control. While no differences in feed efficiency and rate of gain were observed. Lean color scores were improved linearly with Mg mica supplementation.

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EFFECT OF MAGNESIUM MICA ON LIVE WEIGHT GAIN AND CARCASS CHARACTERISTICS

J. T. Wagner, D. R. Gill, and F. N. Owens

Abstract

Large frame, mixed breed steers (n=467; 793 kg) of similar frame size and muscle thickness were allotted to one of 24 pens (20 or 21 steers per pen) for serial harvest (six pens per harvest date) after 117, 131, 145, or 159 d on feed. Pens were assigned randomly to treatment for feeding of 0, 926, or 1801 ppm supplemental Mg from Mg mica. At 28 d intervals and 7 d prior to harvest, live weights were measured. Following a 36 h chill, carcass quality and yield grade data were obtained. No differences in live performance or carcass characteristics were detected, although carcass quality and yield grade increased with days on feed.

(Key Words: Magnesium Mica, Steers, Carcass Characteristics, Serial Harvest.)

Introduction

Magnesium mica is a mined silicate used by the feed industry as a pellet binder. Sharp et al. (1993) reported that pellet quality and production rates of a 20 percent protein range cube increased with the addition of Mg mica. Studies conducted by Coffey and Brazle (1996) and Coffey et al. (1996)

suggested that feeding Mg mica to steers during the pasture (growing) phase or in the feedlot phase increased marbling scores and the percent of carcasses grading U.S. Choice. No detrimental effects on feed efficiency, costs of gain, carcass weight or fat thickness were observed. The value of these cattle at harvest is expected to be increased due to the increased percentage of U.S. Choice carcasses without affecting other growth traits such as efficiency, yield grade or carcass weight.

Cattle must be marketed at the correct stage of production to optimize profitability. When marketing on a carcass basis, the percentage of cattle grading U.S. Choice will influence greatly the value of a pen of cattle. During 1997, the price paid for U.S. Choice carcasses averaged $7.67/cwt more than for carcasses that graded U.S. Select. As days fed increases, percentage U.S. Choice generally increases. However, if cattle are fed too long and the percentage of carcasses that are U.S. yield graded 4 or 5 grows, carcasses will be discounted. During 1997, discounts averaged $12/cwt and $17/cwt for yield grade 4 and 5 carcasses, respectively. Therefore, if the percentage of carcasses graded U.S. Choice could be increased without affecting yield grade, profitability would be enhanced. Additional factors that influence the length of the feeding period are feed costs and cattle prices. This study was conducted to evaluate the effect of supplemental magnesium mica on carcass characteristics and feed efficiency. Days fed were varied so that the effect of Mg mica on marbling could be estimated. Numerous investigators have shown that as days fed increases, marbling scores generally increase (Van Koevering et al., 1995;

Hicks et al., 1987; Williams et al., 1989; May et al., 1992; McKeith et al., 1985; Dolezal et al., 1982; Zinn et al., 1970a). Therefore, serial harvest should increase the precision of detecting the effect of Mg mica upon carcass quality.

Materials and Methods

Large frame, yearling, crossbred steers (n=467), primarily crosses of British and Continental cattle, that had grazed together during the summer in the high plains of Texas, were obtained. Of these steers, one-half were processed and sorted into 12 pens of 20 to 21 head each upon arrival; the remaining steers were processed and sorted the following day into an additional 12 pens. At processing, steers were individually identified and weighed. Routine feedlot vaccinations (IBR, PI-3, and 7-way clostridial vaccines) were administered. All steers were implanted on d 0 with zeranol; steers were reimplanted with 120 mg of trenbolone acetate plus 24 mg of estradiol 90 d prior to the anticipated harvest date. Steers were dewormed with Valbazen® on d 28 after worm populations in fecal samples were detected. The diets (Tables 7 and 8) fed, prepared at a commercial feedlot in Guymon, OK, were trucked twice daily to Panhandle State University for feeding at the research facility.

Pens were randomly assigned into four harvest dates (6 pens/harvest date) and also into three treatment groups (2 pens/treatment/harvest date) for supplementing with Mg mica. Magnesium mica, typically containing 7.83% Mg (Table 3), was fed daily at rates of either 0, 4, or 8 oz per head. A special supplement to carry the Mg was fed at 1 lb per head per d; the remainder of the supplement was composed of ground milo. This supplement was top-dressed onto feed in each bunk twice each day. The basal diet assayed at 2400 ppm Mg; at the mean level of feed intake achieved, Mg supplements increased Mg concentration in the diet by 926 and 1801 ppm.

Initial cattle weights were not shrunk because following transport the cattle already were shrunk. However, weights taken during the trial, on d 28, 56, and 84 were pencil shrunk 4% to account for digestive tract fill. All final weights for steers were taken 7 d prior to each harvest date. The final live weights were pencil shrunk only 2% to account for fill and to calculate gain between weighing and harvest dates. These weights were also used as harvest pay weights. On d 117, 131, 145, and 159, six pens of cattle, two from each treatment, were transported to Dodge City, KS where they were harvested at a commercial harvest facility. At 36 h postmortem, carcass characteristics were measured.

The GLM procedures of SAS were used for data analysis. No significant interactions were detected between days fed and Mg mica treatments. Therefore, data were pooled across days fed for analysis.

Results and Discussion

Live weight, overall ADG, and feed to gain ratios were not significantly affected by treatment (Table 1). Differences among treatments were observed for various traits at all harvest dates. However, these differences were not significant when data were pooled for analysis. Carcass weight, marbling score, and yield grade increased as days fed increased (Table 5), but no differences were observed in carcass traits among treatments (Table 2). The effects of days fed on performance and carcass measurements are discussed in a subsequent chapter and will not be addressed at this time. Carcass weights, dressing percentage, and kidney, heart and pelvic fat all increased as days fed increased, but no differences among treatments were detected. These effects of Mg mica support those reported by Coffey and Brazle (1996), as no differences in carcass weight, average daily gain, efficiency or fat thickness were observed.

As expected, with increased days fed, yield grade and marbling scores tended to respond linearly, but, again no differences were found among treatments; the percentage of carcasses grading U.S. Choice also increased but no effects ($P>.05$) of Mg supplementation were detected. Similar time trends were observed for the percentage of carcasses that graded premium U.S. Choice.

Marbling scores were not increased, as suggested by Coffey and Brazle (1996), with the supplementation of Mg mica. However, the diet consumed in this trial was a corn-based diet, while the Kansas State University study was performed using a grain-sorghum based diet.

Magnesium requirements are suggested by the NRC (1996) to be .10% or 1000 ppm and the maximum tolerable level is reported as .40%. The levels of Mg fed in the current study, and many others, exceed these requirements to varying degrees. Magnesium levels of the basal diet were 2400 ppm Mg; at the mean level of feed intake achieved, Mg supplements increased Mg concentration in the diet by 926 and 1801 ppm. In the study conducted by

Coffey and Brazle (1996), diets contained Mg at 1600 and 1900 ppm for the control and MM supplemented diets, respectively. These levels were calculated from theoretical levels of Mg present in the feed ingredients reported. Also, in work reported by Zinn et al. (1996) Mg was consumed at levels of 1800 and 3200 ppm in diets to compare growth responses of feedlot cattle to laidlomycin propionate. Zinn et al. (1996) also reported that in the absence of laidlomycin propionate, the increased Mg caused a decrease in ruminal starch digestion. An explanation for this apparent interaction does not appear to be readily available.

Implications

Supplementation of a corn-based feedlot diet with 900 and 1800 ppm Mg from Mg mica had no detectable effect on cattle performance or carcass characteristics.

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EFFECT OF DAYS FED ON LIVE WEIGHT GAIN AND CARCASS CHARACTERISTICS

J. T. Wagner, D. R. Gill, and F. N. Owens

Abstract

Large frame, mixed breed steers (n=467) were allotted randomly to one of 24 pens with six pens being serially harvested on days 117, 131, 145, and 159 of the feeding period. Steers were implanted on day 0 with zeranol and reimplanted 90 days prior to harvest with 120 mg of trenbolone acetate and 24 mg of estradiol. Live weights were measured at 28 d intervals and again 7 d prior to harvest. Average daily gain, feed efficiency, dry matter intake, carcass characteristics and net returns were evaluated. Following a 36 h chill, quality and yield grade data were obtained. Average daily gain and feed efficiency were not altered by days on feed although because dressing percentage increased with longer feeding times, feed efficiency on a carcass adjusted basis (carcass weight/.62) increased linearly ($P<.01$) with longer feeding times (5.8, 5.6, 5.5 and 5.2 lb. feed/lb. gain for steers fed the four different durations). As time on feed increased, carcass weight, dressing percent, marbling score, overall maturity, ribeye area, yield grade and kidney, pelvic and heart fat all increased linearly ($P<.01$). Quadratic effects ($P<.01$) were also observed for carcass weight, dressing percent, maturity score, ribeye area, and kidney, pelvic

and heart fat. Quadratic effects (P<.05) were observed in regard to marbling score. The percentage of carcasses which graded low choice or above increased linearly (P<.05) as time on feed increased. Estimated return per head increased linearly (P<.01) when priced on a grid basis while linear and quadratic effects (P<.01; P<.05) were observed when priced through the Oklahoma State University Boxed Beef Calculator. Numeric increases (P=.10) in return per head (-$5.74 to $8.62) were also observed had steers been marketed on a constant live weight bid.

(Key Words: Steers, Carcass Characteristics, Serial Harvest.)

Introduction

Marketing feedlot cattle at the correct stage of production can markedly influence profitability. When marketing on a carcass basis, rather than a live basis, marketing too early can increase discounts for inadequate carcass grades and light carcass weights. During 1997, carcasses graded U.S. Select received an average of $7.67/cwt less than those graded U.S Choice. For carcasses under 550 lb., an additional weight discount of $25/cwt is often used. Likewise, over finishing cattle generates discounts due to heavy carcass weight and high yield grades. Discounts averaged $12/cwt and $17/cwt for yield grade 4 and 5 carcasses during 1997. Feed costs, cattle type, and prices will also influence the optimum length of the finishing period.

When cattle are fed beyond optimal periods, feed efficiency generally deteriorates because the proportion of lean to fat tissue deposition decreases.

Since feed efficiency is generally one of the most important contributors to the profitability of a cattle feeding operation, feeding cattle for longer than needed is likely to decrease net returns. This study was conducted to evaluate the changes in carcass gains and characteristics and economic value of carcasses of feedlot cattle fed for different lengths of time.

Materials and Methods

Large frame, yearling, crossbred steers (n=467), primarily crosses of British and Continental cattle, that had grazed together during the summer in the high plains of Texas, were obtained. Of these steers, 233 were processed and sorted into 12 pens of 20 to 21 head each upon arrival; the remaining 234 steers were processed and sorted the following day into an additional 12 pens. At processing, steers were individually identified, weighed and routine feedlot vaccinations (IBR, PI-3, and 7-way clostridial vaccines) were administered. Steers were dewormed with Valbazen® on d 28 after worm populations in fecal samples were detected. All steers were implanted on d 0 with zeranol; steers were reimplanted with 120 mg of trenbolone acetate and 24 mg of estradiol 90 d prior to the anticipated harvest date. The diets (Tables 7 and 8), prepared at a commercial feedlot in Guymon, OK, were trucked twice daily to Panhandle State University for feeding.

Initial cattle weights taken at arrival were not pencil shrunk because these cattle already were shrunk due to transport. However, all weights taken during the trial were shrunk by 4% to account for digestive tract fill. All steers were weighed 7 d prior to each harvest date. These final live weights taken were shrunk only 2% to account for fill and the added gain between weighing and harvest dates. On d 117, 131, 145, and 159, six pens of cattle were transported to Dodge City, KS where they were harvested at a commercial harvest facility. At 36 h postmortem, carcass measurements were taken.

Economic returns were estimated for the various feeding periods. Input costs were as follows: purchase price=$70/cwt, feed cost=$8.71/cwt dry matter, and fixed cost (yardage, medication and interest) of $.28/head/day. Cattle were priced on a live, a carcass grid and a boxed beef value basis. The average live weight price for 1997, $65.50/cwt, was used for live value calculations. The price structure for the carcass grid is given in Table 6. Freight of $.18/cwt live weight was added to the input cost for grid value pricing.

Data were analyzed using least squares analysis as a completely randomized design. Treatment sums of squares were separated using least significant differences.

Results and Discussion

Live weight, overall average daily gains, and feed to gain ratios were not significantly different between days fed (Table 4). At 56 d on feed, however, steers harvested on d 117 and 159 had gained less than steers that were harvested on the other dates. Although reimplanting at 28 days on feed might have depressed gain and feed intake for cattle harvested on d 117, no explanation for the decreased rate of gain for the d 159 harvest group is available. These differences in performance disappeared as the study progressed. Feed to gain ratios over the entire trial were similar across harvest dates. In contrast, Hicks et al. (1987) reported that live weight average daily gains and feed efficiencies decreased linearly as time on feed increased.

When live weights were calculated by dividing hot carcass weight by 62%, ADG and feed efficiency improved linearly (P<.01). This is explained as there were no differences in feed efficiency and live weight ADG but dressing percentage increased with days fed. On a carcass adjusted basis, Hicks et al. (1987) reported no differences in ADG or feed efficiency. Van Koevering et al. (1995) observed increased ADG and improved feed efficiency on a carcass adjusted basis only at the second harvest period of 119 days on feed.

Carcass weights increased linearly and quadratically (P<.01) with days fed (Table 5). These findings are in concert with other researchers (Zinn et al., 1970; Hicks et al., 1987; May et al., 1992; Van Koevering et al., 1995) who reported similar linear increases with increased time on feed. Dressing percent also increased linearly and quadratically (P<.01) as days increased. Hicks et al. (1987) also reported linear increases in dressing percent with increasing time on feed. Other studies have also shown that an increased time on feed increases dressing percent (Zinn et al., 1970; Williams et al., 1989; May et al., 1992). In the study by Williams et al. (1989), steers were fed for 84, 112, or 140 days. Dressing percent increased only after 112 days on feed. In contrast, Van Koevering et al. (1995) reported that dressing percent was unaltered for steers when fed for 105, 119, 133, or 147 days.

Marbling scores increased linearly ($P<.01$) with days fed. Likewise, percentages of low choice and premium choice increased linearly ($P<.05$ and $P<.01$) over time. Linear regression revealed that percentage of carcasses grading choice increased by .09% for every additional day that cattle were fed in this study. The percent of carcass weight comprised of kidney, pelvic and heart fat also increased linearly and quadratically ($P<.01$) with days fed. As expected, with increased days fed and increased fat deposition, yield grade increased linearly ($P<.01$). The percent of carcasses receiving yield grades of 4.5 or greater increased linearly and quadratically ($P<.01$) with days fed while the percent of carcasses receiving yield grades of 2 or less decreased linearly ($P<.01$) with days fed. Linear regression indicated that percentage of carcasses with yield grades above 4 increased by .1% for every additional day that cattle were fed in this study.

Maturity score increased linearly ($P<.01$). This change was surprisingly large over a 6-wk period. However, increases in maturity have been reported (McKeith et al., 1985; Dolezal et al., 1982; Tatum et al., 1980; May et al., 1992; Van Koevering et al., 1995) in numerous serial harvest studies.

Linear, quadratic and cubic ($P<.01$) increases were detected in ribeye area. Similar observations were reported by Williams et al. (1989), May et al. (1992), and Hicks et al., (1987), while other investigators (Dolezal et al., 1982; Tatum et al., 1980; Van Koevering et al., 1995) have reported inconsistent ribeye area responses to days on feed. However, when expressed as ribeye area per 100 lb. of carcass weight, linear ($P<.01$) decreases were observed.

Special considerations were made during value calculations for stipulations required during the experiment. Heavy weight discounts were not used for pricing because heavy weight steers were removed at early harvest dates of this study. Yield grade discounts were not applied to carcasses until calculated yield grades reached 4.5. Discounts were applied at this level because the U.S.D.A. yield grades assigned visually all were much lower than yield grades actually calculated from component measurements. U.S.D.A. yield grades of 4 or greater were assigned to 1, 0, 5, and 4 carcasses on harvest days of 117, 131, 145, and 159, respectively; in contrast, the number of steers whose calculated yield grades were 4 and 5 far exceeded the number of visually classified U.S.D.A. yield grade 4 and 5 carcasses (Table 5).

When marketed on a live weight basis, net return tended to increase ($P=.10$) in a linear trend as days fed increased with return increasing by $14.36 per head from feeding 42 days longer. This reflects the fact that cost of gain was lower than live weight price. When using the carcass grid for marketing, net return showed a linear increase ($P<.01$) with days fed with return increasing by $36.24 per head from feeding 42 days longer. This can be attributed to increased carcass weights and a higher percent of U.S. Choice carcasses. When the OSU Boxed Beef Calculator is used for pricing, net return increased both linearly ($P<.01$) and quadratically ($P<.05$) with return increasing by $33.90 per head from feeding 42 days longer. Multiple regression indicated that if sold on a live weight basis, feeding these steers forever would maximize return, whereas on a carcass grid basis, these cattle should have been fed for 1746 days. Based on value of boxed beef, return per head was at a minimum on day 118 and increased quadratically the longer cattle were fed. These estimates all indicate that these cattle should have been fed longer than 159 days.

Based on the grid system, considering carcass value alone, carcass value was maximum at 145 days on feed after which the discount for yield grade (assuming a $12 discount for all YG 4 and 5 carcasses) began to exceed the added value from quality grade (assuming a $7.67 discount for steers not reaching the choice grade). At this point in time, 69% of the steers would have graded choice and 7.5% of the cattle would have had yield grades above 4.0.

Implications

Carcass value increased with days on feed up to 145 days when the discount for high yield grades outpaced the increased value from higher quality grades. Because dressing percentage increased with days on feed, marketing on a grid or boxed beef system favored longer days on feed. With the large frame cattle in this experiment, feed to gain ratio was not depressed with longer time on feed (5.8 vs. 5.8). However, on a carcass weight (62% dress) basis, feed to gain ratio was improved by feeding more days (5.8 vs. 5.6, 5.5, and 5.2 for 117, 131, 145 and 159 days on feed). Profit per day as well as profit per head was increasing over time; this indicates that replacing these cattle with a new set would not have proven beneficial economically.

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Table 1. Effect of magnesium mica on live performance.

	Level of magnesium mica, oz		
Performance trait[a]	0	4	8
Number of steers	151	153	163
Number of pens	8	8	8
Weight, lb			
Initial	793	791	794
Final	1303	1292	1307
Daily gains, lb			
0-56 days	3.61	3.63	3.65
56-harvest	3.75	3.63	3.72
0-harvest	3.70	3.64	3.69
Dry matter intake	21.33	21.09	21.67
Feed/Gain	5.79	5.79	5.89

[a]P>.05 for all mean comparisons.

Table 2. Effect of magnesium mica on carcass characteristics.

	Level of magnesium mica, oz.		
Carcass Trait[a]	0	4	8
Hot carcass weight, lb	826	816	824
Dressing percent	63.68	63.53	63.44
Maturity score	162.5	164.8	160.5
KPH, %	2.16	2.14	2.18
Marbling score[b]	424	428	432
Percent low choice	50.52	51.03	49.62
Percent premium choice	12.70	13.08	13.24
Ribeye area, sq in	13.07	12.84	12.96
Yield grade	3.26	3.36	3.31

[a]$P>.05$ for all mean comparisons.

[b]300-399, slight; 400-499, small.

Table 3. Typical Magnesium-Mica Analysis

Element	Guaranteed %	Typical %
Magnesium	8.0	8.0-9.0
Iron	4.0	4.0-5.0
Potassium	2.0	2.0-2.5
Calcium		1.00
Sodium		0.56
Phosphorus		0.35
Manganese		0.065
Cobalt		0.05
Zinc		0.05
Copper		0.006
Sulfur		0.002
Chloride		0.001

Table 4. Effect of days fed on live performance.

	Days fed			
Performance trait	117	131	145	159
Number of steers	117	115	120	115
Number of pens	6	6	6	6
Weight, lb.				
Initial	794	791	794	792
Final[L]	1218	1280	1332	1374
Average daily gains				
0-56 days	3.54[a]	3.89[bc]	3.71[ac]	3.39[a]
56-harvest	3.70[a]	3.60[a]	3.71[a]	3.80[b]
0-harvest	3.62	3.72	3.71	3.65
Feed/Gain	5.83	5.89	5.80	5.77
Carcass adjusted average daily gains[dL]	3.62	3.89	3.89	4.01
Carcass adjusted feed/gain[L]	5.83	5.61	5.55	5.24
Dry matter intake	21.10	21.85	21.45	21.06

[a,b,c]Means with different superscripts differ (P<.05).

[L]Values are linear (P<.01).

[d] Average daily gain calculated with hot carcass weight/.62.

Table 5. Effect of days fed on carcass characteristics.

	Days fed				Effect	
Carcass trait	117	131	145	159	Linear	Quadratic
Hot carcass wt, lb.	755	807	841	887	.01	.01
Dressing percent	62.3	63.4	63.6	64.9	.01	.01
KPH, %	1.92	2.16	2.22	2.34	.01	.01
Maturity score	154.2	161.2	165.1	170.1	.01	.01
Marbling score[a]	400	413	441	457	.01	.05
Low choice, %	39.47	46.90	53.41	61.79	.05	-
Premium choice, %	7.67	7.85	18.16	18.34	.01	-
Ribeye area, sq. in.	12.79	12.90	12.52	13.61	.01	.01
Ribeye area per cwt. of hot carcass wt.	1.70	1.61	1.49	1.54	.01	-
Fat thickness, in.	0.37	0.45	0.50	0.59	.01	.01
Yield grade	2.78	3.17	3.59	3.70	.01	-
Yield grade 1&2, %	61.55	42.58	22.07	15.02	.01	-
Yield grade >4.5, %	.83	2.63	6.95	17.49	.01	.01
Net return, $/head						
Live wt basis	-5.74	-1.48	4.23	8.62	-	-
Grid	-23.38	-4.29	2.58	12.86	.01	-
Box beef	-11.58	-4.22	0.33	22.32	.01	.05

[a]300-399, slight; 400-499, small.

Table 6. Discounts and premiums for determining carcass value in a grid structure.

Base value	Quality grade		Yield grade	
$106.83/cwt	Standard	-$14	1	+$ 3
	Select	-$ 7.67	2	+$ 2
	Choice	0	3	0
	Upper 2/3 choice	+$ 2	4	-$12
	Prime	+$ 5	5	-$17

Table 7. Composition of start-up diets and calculated nutrient values.

		% of Ration, Dry Matter		
Ingredient	**%Dry Matter**	**1**	**2**	**3**
Corn, steam flaked	78.5	43.03	55.23	63.41
Alfalfa hay	84.0	35.14	21.49	12.87
Corn silage	33.0	9.52	8.68	7.35
Starting supplement	59.1	8.52	5.04	2.47
Cottonseed meal	87.7	3.79	4.99	6.11
Finishing supplement	69.2		2.46	4.34
Fat	99.0		2.11	3.45
Calculated nutrient value	**Units**	**Dry matter basis**		
Dry matter	%	69.34	70.35	71.80
NE maintenance	Mcal/lb.	.83	.91	.96
NE gain	Mcal/lb.	.53	.59	.63
Roughage	% of DM	44.65	30.17	20.22
Crude protein	% of DM	14.43	14.30	14.46
Non-protein N	% of DM	1.68	2.49	3.13
UIP	% of CP	32.68	34.48	35.58
UIP	% of DM	4.72	4.93	5.14
DIP	% of DM	9.72	9.37	9.31
Ether extract	% of DM	3.09	5.27	6.66
Crude fiber	% of DM	16.60	12.01	9.02
Calcium	% of DM	.63	.66	.70
Phosphorus	% of DM	.36	.35	.35
Magnesium	% of DM	.23	.23	.24
Potassium	% of DM	1.41	1.24	1.14
Sulfur	% of DM	.23	.21	.20
Copper	ppm	35.11	30.84	28.12
Selenium	ppm	.43	.37	.33
Zinc	ppm	165.75	157.53	153.31
Rumensin	g/ton	14.83	18.17	20.87
Tylan	g/ton	13.35	11.28	9.84

Table 8. Composition of finishing diet and calculated nutrient values.

Ingredient	% Dry matter	% of Ration, Dry Matter
Corn, steam flaked	78.9	73.14
Corn silage	36.0	9.48
Cottonseed meal	89.0	6.73
Finishing supplement	70.2	6.49
Fat	99.0	4.16
Calculated nutrient value	**Units**	**Dry matter basis**
Dry matter	%	71.41
NE maintenance	Mcal/lb.	1.00
NE gain	Mcal/lb.	.67
Roughage	% of DM	9.48
Crude protein	% of DM	13.81
Non-protein N	% of DM	3.51
UIP	% of CP	37.54
UIP	% of DM	5.18
DIP	% of DM	8.62
Ether extract	% of DM	7.46
Crude fiber	% of DM	5.11
Calcium	% of DM	.75
Phosphorus	% of DM	.35
Magnesium	% of DM	.24
Potassium	% of DM	.80
Sulfur	% of DM	.18
Copper	ppm	29.66
Selenium	ppm	.20
Zinc	ppm	151.10
Rumensin	g/ton	25.07
Tylan	g/ton	9.02

VITA

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Master of Science

Thesis: EFFECTS OF DAYS ON FEED AND MAGNESIUM MICA ON PERFORMANCE AND CARCASS CHARACTERISTICS OF FEEDLOT STEERS

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