# THE EFFECTS OF WET DISTILLERS GRAINS PLUS SOLUBLES AND ENERGY OF THE HEALTH AND PERFORMANCE OF RECEIVING CALVES

By

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# NOMENCLATURE

| | |
|---|---|
| ADG | average daily gain |
| BM | ring dried blood meal |
| BRD | bovine respiratory disease |
| BRSV | bovine respiratory syncytial virus |
| BVDV | bovine viral diarrhea virus |
| BW | body weigh |
| CP | crude protein |
| CS | corn silage |
| CWDGS | corn wet distillers grains plus solubles |
| D | day |
| DDGS | dry distillers grains plus solubles |
| DGS | distillers grains with solubles |
| DIP | degradable intake protein |
| DM | dry matter |
| DMI | dry matter intake |
| DRC | dry rolled corn |
| EP | escape protein |
| F:G | feed to gain ratio |
| FGC | finely ground corn |
| FTH | feather meal |

| | |
|---|---|
| G:F | gain to feed ratio |
| H | hour |
| HMC | high moisture corn |
| IBR | infectious bovine rhinotracheitis |
| LE | low energy |
| LSMeans | least square means |
| ME | metabolizable energy |
| MP | metabolizable protein |
| NEg | net energy for gain |
| PI3 | parainfluenza type 3 |
| PI-BVDV | persistently infected with bovine viral diarrhea virus |
| SBM | soybean meal |
| SEM | standard error of the mean |
| SFC | steam flaked corn |
| SWDGS | sorghum wet distillers grains |
| TRT | treatment |
| WCGF | wet corn gluten feed |
| WDB | wet distillers byproducts |
| WDGS | wet distillers grains plus solubles |
| WSBRC | Willard Sparks Beef Research Center |

# CHAPTER I

## INTRODUCTION

Newly received feedlot cattle are submitted to multiple stressors and pathogens as they travel through marketing channels between the ranch of origin and the feedlot (Duff and Galyean, 2007). Stress caused by weaning, transportation, inclement weather, nutritional deprivation, commingling, and processing lowers their level of disease resistance (Lalman and Smith). Associated with these stressors is incidence of bovine respiratory disease (BRD), the most important and costly disease of feedlot cattle. A reported 75% of feedlot morbidity and 50% of mortality can be attributed to BRD (Smith, 1998). Vaccination, deworming, and balanced nutrition are all intended to increase the level of disease resistance (Lalman and Smith). Effective management of calves before and after arrival at the feedlot can improve health and performance. Management practices (weaning, castrating, dehorning, etc.) associated with preconditioning are designed to reduce the impact of stress during the shipping and receiving period (Lalman and Smith). Recent surveys indicate that despite improved vaccines and antimicrobial drugs, BRD mortality rates are not improving (Loneragan et al., 2001; Babcock et al., 2006). Gardner et al. (1999) showed that cattle treated for signs of BRD had 4% lower average daily gain (ADG), 1.7% lower final weights, and 2.6% lighter carcasses.

Diets with increased energy density that are formulated to provide adequate protein and other nutrients are likely to increase ADG and G:F compared with low-energy receiving diets, without substantially altering the occurrence of BRD (Duff and Galyean, 2007). Fluharty et al. (1994) conducted a feedlot receiving experiment with newly weaned calves that had not been previously exposed to creep feed to determine the effects of energy density and protein source in receiving diets containing approximately 13% CP on steer performance and total tract nutrient digestion. High-energy diets resulted in an 8.7% improvement in feed efficiency vs. low-energy diets (Fluharty et al., 1994). Although corn has traditionally been used, corn-milling byproducts (wet corn gluten feed, WCGF; or wet distillers grains plus solubles, WDGS) are increasing in supply and provide alternate sources of protein and energy for feedlot cattle (Klopfenstein et al., 2008). Research has shown increased cattle performance when distillers grains are included in feedlot diets with traditional feed sources such as DRC (Larson et al., 1993; Ham et al., 1994; Al- Suwaiegh et al., 2002), high moisture corn (HMC) and steam flaked corn (SFC) (Corrigan, 2007) as compared to traditional feed sources fed alone. Feeding distillers byproducts as a source of both protein and energy in feedlot diets enables the byproduct to be utilized rapidly, in a concentrated area, and with fewer cattle (Larson et al., 1993). Since WCGF is a fibrous byproduct that is an excellent energy source, the inclusion of WCGF in receiving diets can improve the feed efficiency of calves, provided the metabolizable protein requirement is met (Ham et al., 1995; McCoy et al., 1998; Richards et al., 1998). Wet distillers grains have greater feeding value than dry-rolled corn in cattle finishing diets, and ADG and G:F have been shown to be maximized at inclusion rates of approximately 30% of the diet (DM basis) in DRC based diets (Klopfenstein et al., 2008).

The objectives of the experiments presented include: 1) Evaluate the inclusion of WDGS in receiving diets on the health and performance of high-risk calves; and 2) Determine the effects of altering energy density in high by-product diets on health and receiving performance of calves.

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# CHAPTER II

# REVIEW OF LITERATURE

## BOVINE RESPIRATORY DISEASE

Bovine respiratory disease (BRD) 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 rhinotracheitis (IBR), bovine viral diarrhea virus (BVDV), bovine respiratory syncytial virus (BRSV), bovine enteric coronavirus, and parainfluenza type 3 (PI3)], bacterial (Mannheimia haemolytica, Pasteurella multocida, Haemophilus somnus), and mycoplasmal (Ellis, 2001; Plummer et al., 2004). Of the bacterial species, *Mannheimia haemolytica*, *Pasteurella multocida*, and *Histophilus somni* are of primary concern, with *Mannheimia haemolytica* serotype 1 being the organism most commonly associated with BRD (Pandher et al., 1998).

Morbidity and mortality from BRD in newly weaned/received cattle continues to be the most significant health problems facing the US beef cattle industry. Calf morbidity and mortality associated with BRD are estimated to cost the U.S. beef industry approximately $500 million annually (NASS, 1996). A survey (USDAAPHIS, 1994) of small feedlots (100 to 1,000 animals marketed annually) throughout the United States indicated that death losses ranged from 1.5 to 2.7 per 100 animals marketed, and approximately 70% of these deaths are attributed to respiratory disease (Galyean et al., 1999). Factors contributing to the cost of these diseases include the cost of deceased animals, feed resources lost, pharmaceuticals purchased, inefficiencies of production of those animals that survive, but that have poor performance, and increased labor and psychological stress placed on the feedlot personnel (Loerch and Fluharty, 1999). Environmental risk factors include climate, ambient temperature, dust particles, stocking density, humidity, ventilation, and shipping distance. Epidemiological factors include microbial agent(s), mode of transmission, parasite density dependence, infectious period, latent and carrier periods, and virulence (Snowder et al., 2006).

Bovine viral diarrhea virus causes infection and disease in cattle, with involvement of 1 or more organ systems (Baker, 1995; Fulton, et al., 2000). The conditions range from inapparent infection in postnatal calves to severe, fatal systemic diseases, such as mucosal disease (Baker, 1995). BVDV has been associated with clinical signs and lesions of BRD (Potgeiter, et al., 1995; Lehmkhul and Gough, 1977; Richer et al., 1988). The involvement of BVDV in BRD has been demonstrated by (1) experimental infections, (2) isolation of virus and, or, identification of BVDV antigen in lesions and, or, other respiratory tract samples from calves with respiratory signs or lesions, and (3) demonstration of active infection through seroconversions in groups of cattle with BRD (Fulton et al., 2002).

Calves that are persistently infected with BVDV (PI-BVDV) animals are of primary concern. When cows are exposed to BVDV during d 45 to 120 of pregnancy the calves incorporate the virus into body tissues and their immune systems do not recognize it as a pathogen. Calves that are PI-BVDV cannot be distinguished from calves not PI-BVDV by visual or clinical observation, and PI-BVDV calves shed the virus their entire lives. Healthy, nonexposed animals will develop signs of disease and build an immune response to the virus when exposed to PI-BVDV animals (Burciage-Robles, 2009). The prevalence of PI-BVDV cattle arriving in commercial feedlots has been reported at 0.3% (Loneragan et al., 2005). Single and multiple vaccination against BVDV prior to PI introduction has been shown effective in preventing disease incidence (Step et al., 2009).

### *Management of BRD*

It is generally accepted that a variable, but relatively high percentage of animals will succumb to BRD; thus, accurate diagnosis is critical in practical situations. Most animals are removed for examination and treatment for BRD on or before d 27 of the receiving period (Buhman et al., 2000). Traditional methods for detecting morbid cattle include visual appraisal once or twice daily, with animals displaying various signs including nasal or ocular discharge, depression, lethargy, emaciated body condition, labored breathing, or any combination of these, being removed from pens for further evaluation (Duff and Galyean, 2007). Symptomatic animals with a rectal temperature ≥39.7°C are usually considered morbid and given therapeutic treatment (Duff and Galyean, 2007).

In a review of preconditioning studies, Cole (1985) observed that preconditioning decreased feedlot morbidity and mortality.  Step et al. (2008) reported that calves weaned 45 d prior to shipment had lower BRD rates, regardless of vaccination status at weaning, than calves transported from the same ranch immediately at weaning or calves assembled at auction markets. Nutrition, including deficiencies caused by prior management and low intake by stressed calves upon arrival, can also impact the susceptibility of cattle to BRD (Galyean et al., 1999; Duff and Galyean, 2007). Vaccination, including IBR, PI3, BVDV, and BRSV vaccines, is an integral part of preconditioning programs. Upon arrival at a feedlot, cattle are usually vaccinated against many of the pathogens that can be part of the BRD complex (NAHMS, 2000).

## FEEDING ETHANOL BYPRODUCTS TO CATTLE

### *Byproducts and distillers grains*

Distillers grains are rich in protein, fiber, and fat, and can be included in a wide variety of diets as a source of protein and energy replacing corn without detrimental effects of a starch-based energy source (Ham et al., 1994). Since the passing of the 2005 energy bill, ethanol production has dramatically increased. The energy bill mandated that 4 billion gallons of renewable fuel be added to the gasoline supply in 2006. In 2007, 4.7 billion gallons were to be added, and by 2012, 7.5 billion gallons would be required to be added to the gasoline supply (Yacobucci, 2006). In 2007, the United States surpassed Brazil as the leading ethanol producer (RFA, 2008). In 2009, approximately 14.6 million metric tons of distillers grains were produced in North America with 64% of the total being dried distillers grains (DDG) and 36% wet distillers grains (WDG) (RFA, 2008). Byproducts from the ethanol industry are gaining popularity as feedstuffs in the cattle industry because of their availability, nutrient value, and cost (Leupp, 2008).

Ethanol may be produced from corn by one of two ways, dry milling or wet milling. The majority of ethanol produced in the United States is from dry milling (Bothast and Schlicher, 2005). Wet distillers by-products have approximately 97 to 147% the net energy value of corn (Stock et al., 1999). The energy value of wet distillers by-products may be affected by the type of grain used in the fermentation process (corn vs grain sorghum) and the amount of solubles added to the distillers grains (Stock et al., 1999). Byproducts from the wet milling process used as livestock feeds include, corn gluten feed (CGF), corn gluten meal (CGM), corn germ meal, and condensed fermented corn extractives (Loy and Wright, 2003). Corn gluten feed is composed primarily of bran and steep (Stock et al., 1999). Corn gluten feed is lower in both CP (14 to 24%, DM basis) and escape protein (20 to 30%, % of CP) than CGM, but it is high in net energy for gain (90 to 114% of corn; DM basis) (Stock et al., 1999). The dry milling process produces byproducts such as thin stillage, wet and dry distillers grains, condensed distillers solubles, and wet and dry distillers grains with solubles (Kalscheur et al., 2008). Drying distillers by-products reduces their net energy value, but does not seem to affect their protein value (Stock et al., 1999).

The dry milling process utilizes the entire corn kernel (Leupp, 2008). The process begins by grinding clean corn into flour via a hammer mill. The flour or meal is mixed with water to form a mash after which alpha amylase enzymes are added. The mash is then cooked above 100°C and the starch is liquefied. The mash is cooled and glucoamylase enzyme is added to convert the liquefied starch to glucose. Next, yeast is added to the cooled mash in order to initiate fermentation, which will last 48-72 h. ammonium sulfate or urea may be added as a nutrient for yeast growth. This fermented mash is then distilled and dehydrated to remove the ethanol. The product remaining after distillation is referred to as whole stillage. Whole stillage is centrifuged to separate the liquid (thin stillage) from the solids (WDG) (Leupp, 2008).

Larson et al. (1993) conducted a series of experiments designed to evaluate WDGS fed as a protein source or as an energy source. The hypothesis was that locating an ethanol plant adjacent to a feedlot would allow feeding of the product wet, eliminating the necessity of drying the by-product. The WDGS was fed at 5.2 and 12.6% of diet DM to supply MP or CP needs. The 40% level in the diet (DM basis) supplied protein and replaced corn in the diet as an energy source. At the 40% level, feed efficiency of the diet was increased 14% compared with the corn control.

Vander Pol et al. (2006) fed 0, 10, 20, 30, 40, and 50% WDGS replacing corn. They found quadratic responses to ADG and G:F and a cubic response in feeding value to WDGS level. Feed efficiency at all levels of WDGS was greater than the corn control diet.

Starch is been removed in the production of ethanol so when DGS are included in the diet, especially at levels above 20% of DM, the amount of starch in the diet is decreased, whereas fiber, protein, and fat are increased. This suggests that subacute acidosis should be reduced and roughage (forage) content of the diet could be reduced when DGS is included in diets above 20% of DM. Acidosis control (Krehbiel et al., 1995) and reduced roughage needs (Farran et al., 2006) have been demonstrated with wet corn gluten feed, which has a similar amount of corn fiber to that in DGS. In addition to supplying NDF and reducing starch in the diet, WDGS adds moisture and protein to the diet. The protein in WDGS reduces the need for protein in the roughage. Therefore, less expensive, lower digestibility forages may be acceptable in diets with reasonably high levels of WDGS (Klopfenstein et al., 2008).

Ahern et al. (2011) determined the energy value of distillers grains relative to corn in high forage diets in an 84 d growing trial. Diets contained dried distiller grains plus solubles (DDGS), WDGS, or dry rolled corn (DRC), with sorghum silage, grass hay, and supplement. Calves were fed either low or high levels of each diet: 1) DRC, 2) DDGS, or 3) WDGS. For all diets, a 60:40 blend of grass hay and sorghum silage was fed with DDGS, WDGS or DRC. There were no interactions between level of supplement inclusion (low or high) and type of feed (DRC, DDGS, or WDGS) (Ahern et al., 2011). The type of feed did not impact initial body weight (BW), ending BW, dry matter intake (DMI), average daily gain (ADG), and feed to gain (F:G). This trial reiterates that distillers (dry or wet) have a high-energy value compared to corn in forage-based diets. The level of starch present at low amounts, the energy density of fat, undegradable protein, and crude fiber are the possible reasons contributing to greater energy value compared to corn as a supplement (Ahern et al., 2011).

Bremer et al. (2011) performed a meta-analysis of feeding calf-feds or yearlings WDGS with different corn processing types. Meta-analyses of feeding WDGS with DRC and high moisture corn (HMC) to either calf-feds or yearlings were conducted to calculate the feeding values of WDGS relative to corn. The feeding value of WDGS was superior to DRC and HMC. The feeding value of WDGS was greater for yearlings than for calf-feds. The combination of WDGS and HMC provided cattle performance superior to DRC with or without WDGS. In all trials, WDGS replaced DRC, HMC, or a blend of the two corn types in diets (0% to 50% of diet DM).

Replacement of corn up to 40% of diet DM as WDGS resulted in superior performance compared to cattle fed no WDGS (Bremer et al., 2011). Dry matter intake, ADG, and F:G improved quadratically as WDGS inclusion level increased. The feeding value of WDGS was consistently greater than corn when WDGS was included up to 40% of diet DM. The feeding value was greater at lower WDGS inclusion levels and decreased as inclusion level increased. The study indicated a greater feeding value of WDGS for yearlings than calf-feds. The feeding value of WDGS, regardless of corn processing type, was greater for yearlings than for calf-feds. Yearling performance improved quadratically as WDGS level increased, regardless of corn processing type (Bremer et al., 2011).

Another trial done by Bremer et al. (2011) evaluated feeding WDGS, replacing HMC with WDGS in diets and feeding WDGS replacing DRC. The trial evaluated replacing each corn type with up to 40% of diet DM as WDGS. The DRC 0% WDGS cattle performed similarly to the winter DRC only fed cattle of the meta-analysis. The data suggests the combination of 47.5% of diet DM as HMC and 40% of diet DM as WDGS has a feeding value equal to 122% of DRC (Bremer et al., 2011).

The results of these trials reiterate the conclusion that the feeding value of WDGS was superior to DRC and HMC. The feeding value of WDGS was greater for yearlings than for calf-feds. The feeding value of WDGS was greater in DRC diets than in corn blend diets. The combination of WDGS and HMC provided cattle performance superior to DRC with or without WDGS (Bremer et al., 2011).

Buckner et al. (2010) conducted a study to compare ensiled or fresh mixed WDGS with straw at two inclusions in growing calf diets. This study evaluated feeding ensiled or freshly mixed WDGS with straw at two blends and the effect of an inoculum with the ensiled mixture on steer calf performance. Treatments included 30 or 45% WDGS (DM basis) mixed with straw and fed either as a fresh mix or ensiled with and without a microbial inoculum. No significant interactions were observed between type and level of mix. Steers fed the ensiled mixes had higher ADG and lower F:G compared to those fed the fresh mix. A 2 x 3 factorial arrangement of dietary treatments was used, including two mixtures of WDGS and straw and three storage types. Ratios were either 30% WDGS with 70% straw or 45% WDGS with 55% straw (DM basis). The ensiled mixtures were stored for 70 days prior to trial initiation and were used throughout the experiment. All of these mixtures were fed at 97.5% of diet DM and 2.5% of the diet DM included a dry supplement.

No interactions ($P > 0.10$) were observed between the ratio of WDGS to straw nor whether the mixes were fed fresh, ensiled without inoculum, or ensiled with inoculum (Buckner et al., 2010). The higher inclusion of WDGS relative to straw resulted in greater ending BW ($P < 0.01$), ADG, and DMI ($P = 0.05$). Dry matter intake was kept constant for steers fed mixes with different storage types, increased ($P = 0.02$) ADG and decreased ($P < 0.01$) F:G was observed for ensiling the mixes compared to feeding them fresh. These data suggest not only that palatability increases, but digestion does as well, which increases ADG and decreases F:G (Buckner et al., 2010).

Nuttelman et al. (2010) compared the energy value of WDG to DRC in high forage diets. DRC was included at 22, 41, and 60% of the diet (DM), and WDGS was included at 15, 25, and 35% of the diet (DM). Cattle consuming WDGS gained more than cattle consuming DRC. Average daily gain increased with increasing levels of DRC and WDGS (Nuttelman et al., 2010). Treatments were arranged in a 2 x 3 factorial design: energy source (WDGS and DRC) fed at three levels (LOW, MEDIUM, and HIGH). All treatments contained 30% sorghum silage and various levels of grass hay depending on the inclusion level of WDGS or DRC. Levels of WDGS were included at 15, 25, or 35% of the diet DM for diets containing WDGS. Dry rolled corn was included at 22, 41, or 60% of the diet DM for treatments containing DRC.

Cattle consuming diets containing WDGS gained 0.1 kg more per day than cattle consuming diets with DRC ($P < 0.01$). Gain efficiency also was improved for cattle consuming WDGS ($P < 0.01$) due to greater ADG and constant DMI. Ending BW responded quadratically ($P < 0.01$) with increasing level of energy. There was a quadratic response for ADG with the MEDIUM and HIGH levels of DRC and WDGS, gaining 0.22 and 0.31 kg more per day, respectively, compared to LOW. Feed efficiency was improved with increased level of DRC and WDGS ($P < 0.01$). The feeding values of WDGS were 147, 149, and 142% the energy value of DRC when included in high forage diets at 15, 25, and 35% of the diet DM. This increased feeding value of WDGS in relation to DRC is attributed to the decreased negative associative effects on fiber digestion that are observed with increasing levels of starch, as well as the higher fat content of the WDGS (Nuttelman et al., 2010). This trial suggests that WDGS contains a higher energy value than DRC with values ranging from 142% to 149% (Nuttelman et al., 2010).

A growing study by Peterson et al. (2009) was used to compare WDGS and solubles ensiled with wheat straw individually fed to crossbred steers. Four blends of ensiled distillers grain and solubles were used to compare performance on growing calves versus feeding ensiled byproducts alone. Increasing the level of distillers grains in the diet increased ADG and DMI. The non-ensiled distillers grain treatments had at least equal ADG and F:G compared to the ensiled treatments.

There were a total of 15 treatments. The first seven treatments included: 25% solubles; 35% solubles and 45% solubles ensiled with ground wheat straw; and 25%

WDGS, 35% WDGS, 45% WDGS and 55% WDGS combined with wheat straw. The next four treatments consisted of a 35% and 45% WDGS ensiled and non-ensiled group. The non-ensiled treatments were made by mixing fresh WDGS and ground wheat straw daily. The last four treatments were blends of solubles. WDGS and wheat straw blends included: 17.5% solubles + 17.5% WDGS; 25% solubles + 10% WDGS; 25% solubles + 20% WDGS; and 26.25% solubles + 8.75% WDGS.

Treatments of 25% and 35% solubles were similar for ADG, but ADG increased for the 45% solubles level. There was a quadratic trend ($P = 0.069$) for F:G to decrease as inclusion of solubles increased. The 35% solubles treatment had the highest F:G, with 45% solubes being the most efficient and 25% solubles in the middle of the other two treatments. The DMI and ADG increased linearly ($P < 0.01$) as the WDGS inclusion increased from 25% to 55%. Feed to gain of WDGS treatment decreased linearly ($P < 0.01$) as the level of inclusion increased. Average daily gain of steers fed solubles and WDGS at the same inclusion rates were not different except for the 25% level of inclusion. Intake was greater for the 25% solubles compared to the 25% WDGS treatment. Differences in DMI ($P < 0.01$) were found between treatments. Steers on the 17.5% solubles + 17.5% WDGS treatment had a lower ($P < 0.01$) intake (4.33 kg) compared to steers on the 25% solubles + 20% WDGS treatment (5.23 kg). Average daily gain tended ($P = 0.08$) to be different among groups. The blends totaling 35% byproduct resulted in gains of 0.45 to 0.50 lb/day, similar to gains achieved with either of the byproducts fed alone. The 25% solubles + 20% WDGS blend also resulted in similar ADG to either of the byproducts fed alone (Peterson et al., 2009).

In summary, calves responded positively to increasing levels of either solubles or WDGS, and the feeding values of solubles were at least equal to those of WDGS. Blends of solubles and WDGS resulted in performances similar to those of either solubles or WDGS fed alone. The WDGS mixed with wheat straw at feeding time gave comparable performance to similar levels of WDGS that had been ensiled for more than 50 days (Peterson et al., 2009).

Rich et al. (2011) performed a finishing trial that evaluated the effects of feeding more than 70% WDGS on feedlot cattle performance. Wet distillers grains plus solubles was fed at 40, 70, 77, and 85% of diet dry matter, while roughage levels ranged from 5 to 25% across treatments. Larger ADG and G:F were observed with 40% WDGS and 5% roughage. Higher levels of WDGS were successfully fed with levels of roughage above 8%, but the diets were less profitable than the 40% WDGS diet. The objectives of this study were to evaluate the effects of feeding increased amounts of WDGS with typical or increasing levels of roughage on feedlot cattle performance (Rich et al., 2011).

Seven treatments included: 1) control (CON) of 85% dry-rolled corn (DRC), 4.7% wheat straw, and 5.0% molasses; 2) (40-5) 40% WDGS, 50.3% DRC, and 4.7% wheat straw; 2) (70-8) 70% WDGS, 16.8% DRC, and 8.2% wheat straw; 4) (77-9) 77.5% WDGS, 8.4% DRC, and 9.1% wheat straw; 5) (85-10) 85% WDGS and 10% wheat straw; 6) (77-17) 77.5% WDGS and 17.5% wheat straw; 7) (70-25) 70% WDGS and 25% wheat straw all on a DM basis.

Steers fed the 40-5 had the greatest ($P < 0.01$) ADG and F:G, but F:G was similar to steers fed the 77-9. Steers fed 70-25 had the lowest ($P < 0.01$) ADG and F:G. Dry matter intake was the greatest ($P < 0.05$) for the 40-5 and CON followed by the 70-8 and

77-17 steers, 77-9, and the 20-25 and 85-10 steers. Steers being fed the CON, 70-8, and 77-9 had similar ADG, followed by steers fed 77-17, then 85-10, which were different ($P < 0.01$). Steers fed CON, 85-10, and 77-17 had similar G:F ($P > 0.10$), but less ($P < 0.05$) than 40-5, 70-8, and 77-9. However, steers fed 85-10, 77-17, and 70-25 were fed 42 days longer.

Rolfe et al. (2011) supplemented modified wet distillers grains with solubles (MDGS) to long yearling steers grazing native ranges. Modified wet distillers grains with solubles were supplemented on the ground to yearling steers with access to native range during summer grazing. Supplemented steers had greater ADG than non-supplemented steers, and were heavier entering the feedlot. Supplemented steers also required 24 fewer days in the feedlot to reach a constant end point, compared to non-supplemented steers. The objective of this research was to determine effects of supplementing MDGS on the ground to long yearling steers while grazing native range (Rolfe et al., 2011).

While grazing cornstalks, calves were supplemented 2.27 kg/steer daily of Sweet Bran® (Cargill, Blair, Neb.). Following the back grounding, steers were allowed to graze smooth bromegrass pastures for approximately 21 days. After grazing brome, steers were relocated to graze Sandhills range at the University of Nebraska Barta Brothers Ranch near Rose, Neb. Summer grazing treatments included: grazing native range with no supplementation (CON), and grazing native range with MDGS supplementation at 0.6% BW (SUPP). Modified distillers grains with solubles were fed daily on the ground. Steers grazed the range for an average of 136 days before entering the feedlot in late September. Steers were limit fed at 1.8% BW (DM basis) for five days before smooth-bromegrass grazing and after summer grazing; initial and final BW for summer were the mean of weights taken on two consecutive days (Rolfe et al., 2011).

At the time of summer treatment assignment, BW was not different between SUPP and CON steers (*P* = 0.36); however, SUPP steers had 0.31 kg greater (*P* < 0.01) ADG during summer grazing than CON steers. Consequently, SUPP steers were 46.72 kg heavier (*P* < 0.01) than CON steers at feedlot entry. When taken to a constant end point, SUPP steers required 24 fewer (*P* < 0.01) days on feed during the finishing phase, compared to CON steers. Supplementing MDGS on the ground at 0.6% BW (DM basis) to long yearling steers grazing native range increased ADG during summer grazing (Rolfe et al., 2011).

Villasanti et al. (2011) looked at the replacement of grazed forage with WDGS and poor quality hay mixtures. Treatments were assigned randomly to 20 paddocks and consisted of: 1) control (CON) at the recommended stocking rate (0.7 AUM/acre), 2) double stocked (1.32 AUM/acre) and supplemented with a mixture of 60% straw and 40% WDGS (STRAW), 3) double stocked (1.37 AUM/acre) and supplemented with 60% hay and 40% WDGS (LOHAY), and 4) double stocked (1.36 AUM/acre) and supplemented with 70% hay and 30% WDGS (HIHAY) (Villasanti et al., 2011).

Similar ADG was observed for the CON and HIHAY treatments (*P* = 0.46); however, steers in the LOHAY and STRAW treatments showed significantly higher ADG than the steers in the CON (*P* < 0.05). Steers in the LOHAY and STRAW treatments also outgained HIHAY treatment steers by 0.13 and 0.12 kg per day, respectively (*P* < 0.05). These data show animal performance was either not affected or improved when supplementing with low-quality forage mixed with WDGS. Total DMI was similar among treatments, varying between 8.07 kg and 7.17 kg –the highest value for the CON and the lowest for the HIGH treatment. When NDF from total DMI was considered, steers in the CON treatment showed higher NDF intake than the steers in the supplemented groups; however, NDF intake (5.85 kg) was similar among the HIHAY, LOHAY, and STRAW treatments (4.85, 5.13, and 4.99 kg respectively) (Villasanti et al., 2011). The findings of this study show mixing WDGS with low-quality forage is an effective tool to increase stocking rates without hurting animal performance, and the reduction in intake increased with the level of fiber in the supplement. From these results the 70:30 blend seems to be the best combination to get the higher amount of grazed forage replacement (Villasanti et al., 2011).

### *Roughage level with byproducts*

A feedlot study tested the response to roughage level and source in diets containing 30% WDGS (Benton et al., 2007). Alfalfa was used as the roughage and was fed at 4 and 8% of diet DM. Cornstalks were evaluated at amounts of NDF similar to the alfalfa (3 and 6 % of diet DM). Corn silage was included as the third roughage source. An all-concentrate diet was included as a control. There was a 1 to 1.5 kg/d increase in DMI due to roughage inclusion, whereas ADG increased 0.09 to 0.22 kg/d. These increases in DMI and ADG are typical of those observed in studies evaluating roughage levels in diets without WDGS (Shain et al., 1999). In this study, cornstalks were as effective as alfalfa and corn silage in diets containing WDGS in providing roughage in terms of response in DMI, ADG, and G:F. These results are contrary to Shain et al. (1999) where wheat straw fed on an equal NDF basis to alfalfa in dry-rolled corn diets was not as efficiently utilized as alfalfa. This suggests the moisture and protein in WDGS do in fact supply characteristics to the diet that allow utilization of low-quality roughages (Klopfenstein et al., 2008).

### *Feeding energy to cattle*

Berry et al. (2004) studied the effects of dietary energy and starch concentrations on performance and health of newly received feedlot calves during a receiving trial. Calves were assigned randomly to one of two dietary energy levels (0.85 or 1.07 Mcal NEg /kg DM) and one of two dietary starch levels (34 or 48% of ME from starch). There were no energy x starch level interactions for performance or health response variables. Daily gain (1.14 kg/d) and gain efficiency (G:F = 0.179) were not affected by increasing dietary energy or starch concentrations ($P < 0.15$). Calves fed low-energy diets consumed ($P < 0.05$) more DM. There was no difference ($P = 0.54$) in morbidity for calves fed high-energy (62.4% calves treated) compared with low-energy (65.8% calves treated) diets. No energy effects occurred ($P < 0.12$) for first or second treatments; however, calves fed the high-energy diets tended ($P = 0.06$) to have a lower percentage of animals treated with a third antimicrobial treatment compared with calves fed the low-energy diets. This study suggests that starch content in high-energy diets mights influence morbidity.

In a study done by Fluharty et al. (1994) they determined the effects of energy density in the diet and protein source on steer performance in a receiving trial. The factors compared were high-energy and low-energy density (1.80 vs 1.48 Mcal/kg of NE, respectively) and protein source (ring-dried blood meal [BM] vs soybean meal [SBM]).

Average daily gain was 10.6% greater ($P < 0.09$) for steers fed BM than for steers fed SBM (1.25 vs 1.13 kg/d, respectively). Bone meal diets resulted in a 7.6% improvement ($P < 0.05$) in feed efficiency compared with those containing SBM. Dry matter intake was lower ($P < 0.05$) for steers fed the high-energy diets than for steers fed the low-energy diets (5.53 vs 6.03 kg/d, respectively). The high-energy diet in this study was approximately 70% concentrate, and the low-energy diet was approximately 45% concentrate. Steers fed the high-energy diets consumed an average of 39.5% more NEg than steers fed the low-energy diets (3.20 and 3.02 Mcal/d for high-energy diets vs. 2.24 and 2.22 Mcal/d for low-energy diets). High-energy diets resulted in an 8.7% improvement ($P < 0.05$) in feed efficiency vs. low-energy diets. Dietary treatment did not affect incidence of morbidity.

McCoy et al. (1998), performed two receiving studies that compared energy source (DRC or WCGF [Minnesota Corn Processors, Columbus, NE; 16.1% CP, 48.5% NDF]) and protein supplement. Supplemental escape protein (EP) was provided by an 80% feather meal (FTH): 20% ring-dried blood meal (BM) blend (CP basis). Diets were formulated to contain a minimum of (DM basis) 9.2% degradable intake protein (DIP).

For receiving trial 1, calves fed WCGF had lower DMI ($P < 0.01$) and gained slower ($P < 0.05$) than calves fed DRC. Feed efficiency was not affected ($P > 0.15$) by energy source, but was improved ($P < 0.10$) with EP supplementation. The MP supply for calves fed DRC was higher ($P < 0.01$) than that for calves fed WCGF and higher ($P < 0.01$) for calves fed supplemental EP than for calves not fed supplemental EP. Less morbidity was observed in calves fed DRC ($P < 0.10$) than in calves fed WCGF and mortality was not affected ($P > 0.15$) by energy source or protein supplement.

For the second receiving trial, calves fed WCGF had lower DMI ($P < 0.01$), gained similarly ($P > 0.15$), and were more efficient ($P < 0.10$) than calves fed DRC. The MP supply of calves fed DRC was higher ($P < 0.01$) than that of calves fed WCGF and higher ($P < 0.05$) for calves fed supplemental EP than for calves not fed supplemental EP. A negative correlation ($P < 0.01$) was observed between MP supply and morbidity, indicating that increased MP supply may improve health. Dietary NEg was higher ($P < 0.05$) for WCGF diets than for DRC diets.

Two experiments were conducted by Parsons et al. (2007) to evaluate the effects of feeding different levels of WCGF and dietary roughage on performance, carcass characteristics, and feeding behavior of feedlot cattle fed diets based on SFC. In experiment 1, steers were fed 4 dietary treatments (DM basis): a standard SFC-based diet containing 9% roughage (CON) and 3 SFC-based diets containing either 40% WCGF and 9% roughage (W9.0), 40% WCGF and 4.5% roughage (W4.5), or 40% WCGF and 0% roughage (W0.0).

Cattle were fed a 64% concentrate starter diet from the time of arrival until 15 d later when the experiment began. On d 0 of the experiment, cattle were switched to a 73% concentrate diet and subsequently adapted to the final diets by increasing the total concentrate level to 82 and 91% at 5- to 7-d intervals. Additional steps were made in 5- to 7-d intervals for the 2 treatments that received less than 9% dietary roughage, so that cattle in the W0.0 treatment group received their finishing diet by d 26 of the study.

For the second experiment, steers were fed 4 dietary treatments (DM basis), including the following: a standard SFC-based control diet containing 9% roughage (CON) and 3 SFC-based diets containing either 20% WCGF and 9% roughage (20W9.0), 40% WCGF and 9% roughage (40W9.0), or 40% WCGF and 4.5% roughage (40W4.5). Three step-up diets (35, 27, and 18% roughage, respectively) were used to adapt the steers to the final treatment diets. Step-up diets for the 20% WCGF treatment contained 20% WCGF. For the 40% WCGF treatments, the 35 and 27% roughage diets contained 20% WCGF, whereas the 18% roughage step-up diet contained 30% WCGF.

For experiment 1, final BW did not differ (*P* = 0.90) between steers fed the CON diet and the average of the WCGF diets, but there was a linear (*P* = 0.04) increase in final BW within the WCGF diets as roughage level increased from 0 to 9%. There was a linear effect (*P* = 0.01) of roughage level within the WCGF diets on ADG, with steers fed higher roughage levels having greater ADG. A linear effect of roughage level (*P* = 0.01) within the WCGF diets was observed for DMI, likely because of the lower DMI of the WCG + 0.0 diet compared with the 4.5 and 9% roughage levels. Steers fed the CON diet had lower (*P* = 0.04) DMI and greater (*P* = 0.03) G:F than those fed WCGF.

For experiment 2, final BW tended to be greater (*P* = 0.14) for steers fed the WCGF diets than for steers fed the CON diet. Average daily gain tended to be less (*P* = 0.08) for steers fed the CON diet than for steers fed the WCGF diets. Steers fed the WCGF diets had higher DMI (*P* < 0.01) then steers fed the CON diet, and increasing roughage level increased (*P* = 0.06) DMI within the 40W diets. Feed efficiency was improved (*P* < 0.01) for steers fed the CON diet compared with steers fed the WCGF diets. In the 40W diets, decreasing the roughage level improved G:F (*P* < 0.01), and among the WCGF diets, cattle fed 20W9.0 had better G:F (*P* = 0.08) than the average of those fed the 40W diets.

The feeding of WCGF in SFC-based diets increased ADG when 4.5 to 9.0% roughage was supplied in Exp. 1. Daily gain also increased with added WCGF in Exp. 2 compared with CON. Overall, diets containing WCGF decreased G:F and increased DMI compared with CON diets. Dry matter intake tended to increase with increasing levels of WCGF; however, ADG did not differ for cattle fed all combinations of WCGF and alfalfa hay. Results of Exp. 2 indicated that increasing levels of WCGF in SFC-based diets did not affect daily DMI or ADG; however, G:F was less for the average of the 40% WCGF diets than for the 20% WCGF, and G:F was greater for steers fed the CON diet than for steers fed diets containing either level of WCGF (Parsons et al., 2007).

## SUMMARY FROM THE LITERATURE

Although BRD is a disease of foremost concern because of its widespread incidence in cattle (Callan and Garry, 2002), BRD can be controlled by decreasing pathogen transmission between animals. Management practices that reduce pathogen introduction, exposure, and transmission are important initial steps. Total eradication of pathogens for BRD is not likely in feedlot environments where introduction of cattle and movement of cattle are usual management activities. Decreasing pathogen transmission between animals can be achieved by removing affected animals and avoiding crowding of animals. Another approach is to reduce the number of susceptible animals by increasing the number of BRD-resistant animals, which can be achieved by the use of vaccines or antibiotics, although some pathogens may be resistant to antibiotics and efficacy of vaccines may be limited in some cases. Vaccines can be effective for reducing not only susceptibility but also for reducing shedding of infectious BRD agents to other calves (Frank et al., 1994, 2003). Due to the rapid growth of the U.S. ethanol industry, there has been an equivalent explosion of growth in the production of ethanol co-products (Solomon et al., 2007; RFA, 2009). As a result of the recent increases in ethanol byproduct production, notably distiller's grains, there has been an enhanced interest in feeding these byproducts to livestock (Weiss et al., 2007). One of the reasons for the continued success of wet distiller's grains plus solubles in feedlots is due to the greater energy value of the wet distiller's grains plus solubles compared to both dry-rolled and high-moisture corn (Vander Pol et al., 2009).

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# CHAPTER III

## EFFECTS OF WET DISTILLERS GRAINS PLUS SOLUBLES BASED RECEIVING DIETS ON HEALTH AND PERFORMANCE OF HIGH-RISK CALVES

ABSTRACT: A randomized complete block design experiment utilizing 180 high-risk crossbred steers (initial BW = 212.3 ± 1.9 kg) was conducted to evaluate the effects of including wet distillers grains plus solubles (WDGS) in a receiving diet on steer performance and health over a 42-d period. Steers were sorted into light and heavy weight blocks and randomly assigned within block to 15 pens, each with 6 steers. Experimental treatments consisted of receiving diets with inclusion of 0%, 15%, or 30% WDGS. Pens were considered the experimental unit and each treatment diet was fed to calves in 10 pens. Cattle were fed 2 times daily with approximately 50% of the daily allowance fed at each feeding. Feed refusals were measured following adverse weather and on weigh days. Steers were individually weighed at the start of the experiment, on d 14, and on d 42. Average daily gain ($P = 0.19$; 0.84, 1.01, and 1.02 kg/d), DMI ($P = 0.10$; 4.67, 5.22, and 5.09 kg/d), G:F ($P = 0.31$; 0.18, 0.19, and 0.20), and animals treated for BRD ($P = 58.33\%$, 43.33%, 43.33%) did not differ among treatments for 0, 15, or 30% WDGS, respectively. Dry matter intake ($P = 0.04$) differed and there tended to be differences ($P = 0.07$) between steers fed WDGS and steers not fed WDGS. During the experiment, 3 steers on the 0% treatment were diagnosed as chronically morbid with bovine respiratory disease (BRD) and were removed from the experiment. There were no deaths during this experiment. Feeding WDGS receiving diets to high-risk calves did not negatively impact animal health or performance. We conclude that up to 30% WDGS can be included in receiving diets for high-risk calves.

Key words: WDGS, high-risk calves, receiving trial

# INTRODUCTION

High-risk calves are young, light-weight calves that have generally not been castrated, dehorned, administered to a proper herd health program, and/or have not received adequate nutrition prior to feedlot arrival to support their genetic potential for growth (Parish, 2010). They are typically more susceptible to developing health problems, especially BRD, and developing effective nutritional programs is often a challenge (Parish, 2010).

Wet distillers grains plus solubles can be used as a replacement for corn and provide supplemental protein and are good sources of rumen un-degradable protein (approximately 50% of CP) (Corrigan et al., 2009; Kononoff and Janicek, 2005; Pokharel et al., 2011). Replacing corn with WDGS can reduce the negative associative affects that the energy from starch can have on fiber digestion (Nuttelman et al., 2009). Distillers grains (dry or wet) have a high energy value relative to corn in forage based diets (Ahern et al., 2011). Distillers grains provide a highly fermentable fiber source that does not negatively impact forage digestion, which fits well into forage production systems (Rolfe et al., 2011).

Feeding WDGS is becoming common among cattle producers (Moore et al., 2011). Feeding WDGS to feedlot cattle is the optimum feed use of distillers grains based on feeding performance and greenhouse gas emissions (Bremer et al., 2011a). Advantages of using WDGS are that it often has a low cost per unit of dry matter, a relatively high energy concentration, and they mix well into a total mixed ration (Kononoff and Janicek, 2005). Disadvantages are higher transportation costs per unit of dry matter, higher storage costs, lower concentrations of rumen degradable protein, and spoilage can be high because it has a relatively short shelf life (Kononoff and Janicek, 2005; Christensen et al., 2010). The objective of this study was to evaluate the inclusion of WDGS in receiving diets on the health and performance of high-risk calves.

## MATERIALS AND METHODS

### *Experiment*

A randomized complete block design experiment utilizing 180 high-risk crossbred steers (initial BW = 212.3 ± 1.82 kg) was conducted at Willard Sparks Beef Research Center (WSBRC) in Stillwater, OK, to evaluate the effects of including wet distillers grains plus solubles (WDGS) in a receiving diet on steer performance and health over a 42 d period. Steers traveled 135 km from the Oklahoma City West Livestock Market in El Reno, OK, to the WSBRC in Stillwater, OK, in the August of 2010. Steers were unloaded, individually weighed and identified with a unique visual tag and a description was obtained. Calves were then allowed access to ad-libitum hay and water during a 24 h rest period prior to processing. The following day steers were sorted into light and heavy weight blocks and randomly assigned within block to 15 pens with 6 steers. Steers were vaccinated with a clostridium bacterin/toxoid (Vision 7, Invervet/Schering-Plough, DeSoto, KS). They were also vaccinated with a 5-way viral (Express 5, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO). Steers were dewormed with ivermectin (Ivomec Plus, Merial, Duluth, GA) and re-vaccinated after 14 d (Express 5, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO). Steers were not implanted for this study. Experimental treatments consisted of receiving diets with inclusion of 0%, 15%, or 30% WDGS (Table 3.1). Pens were considered the experimental unit and each treatment diet was fed to steers in 10 pens. Ration samples were collected once per week and dried in a forced air oven for 48 h at 60°C to determine dry matter. Ration samples were composited gravimetrically and analyzed at a commercial lab (Servi-Tech, Inc. Dodge City, KS) for nutrient composition. Rations were formulated to meet or exceed NRC requirements (Table 3.2). A ground corn and wheat-midd based supplement was included in the ration to provide all necessary vitamins, minerals, and ionophores.

### *Feeding management*

Treatment rations were fed twice daily at 0700 and 1300 h with approximately 50% of the daily allowance fed at each feeding. Steers were fed with a Roto-Mix 84-8 feed mixer wagon (Dodge City, KS). Prairie hay was fed at 1 kg per head for the first seven days. Bunks were cleaned to remove manure, hair, etc. each day before feeding. Steers had ad libitum access to water via an automatic water basin located along the fence line and shared between 2 adjacent pens. Steers were housed in 4.57 × 15.24 m pens with a 4.57 m fence-line feed bunk. Bunks were evaluated twice daily with the goal of 0 to 1 kg of feed remaining at the morning evaluation. Feed refusals were measured following adverse weather and on weigh days.

### *Cattle Management*

Steers were checked daily for signs of bovine respiratory disease (BRD) and assigned a clinical assessment score (CAS) 1 to 4. Calves deemed a CAS 1 or 2 and having a rectal temperature of 40ºC or greater were treated according to treatment protocol. Those having a CAS of 3 or 4 were treated regardless of rectal temperature. All antimicrobials were administered via a subcutaneous injection in the neck following Beef Quality Assurance Guidelines (NCBA, 2001). Cattle assigned a CAS of a 1 or 2 were treated with 40 mg of Florfenicol/kg of BW (Nuflor, Schering-Plough Animal Health, Summit, NJ). If determined to be affected by BRD after a 4 d moratorium cattle were administered 10 mg of enrofloxacin/kg of BW (Baytril 100, Bayer Animal Health, Shawnee Mission, KS). A 2 d moratorium was observed before cattle were evaluated for treatment with the final treatment of 1.0 mg of ceftiofur hydrochloride/kg of BW (Excenel RTU, Pfizer Animal Health, New York, NY).

Steers were individually weighed at the start of the experiment, on d 14, and on d 42. A 2% shrink was applied to d 14 and d 42. During the experiment, 3 steers on the 0% treatment were diagnosed as chronically morbid with bovine respiratory disease (BRD) and were removed from the experiment. All data from these steers were excluded from the performance analysis. There were no deaths during this experiment. All calves that were removed due to health problems other than BRD were removed from the performance analysis. An average dry-matter was calculated for the feeding period and actual DMI consumption was calculated at the end of the study by dividing total pounds of feed dry matter consumed by total head days of a pen. For DMI calculations, any animal that was removed from the study due to poor performance, feed for that animal was removed at 1 × $NE_m$. Net energy recovered was calculated using animal performance and the NRC (2000).

*Statistical Analyses*

Performance data were analyzed as a randomized complete block design using PROC MIXED using block as a random variable, and health data were analyzed using PROC GLIMMIX in SAS (SAS Institute, Cary, N.C.) using block as a random variable. Contrasts were evaluated to compare the 0% WDGS diet that did not include WDGS to the 15 and 30% WDGS diets. Diet was the fixed effect, weight block was the random effect, pen was the experimental unit, and LSMeans was considered significantly different at P < 0.05 and were separated using the PDIFF option of SAS. Calves that were removed from the trial were not included in the performance or health analysis.

## RESULTS AND DISCUSSION

Feedlot performance data are summarized in Table 3.3. Over the entire feeding period ADG (*P* = 0.19; 0.84, 1.01, and 1.02 kg/d), DMI (*P* = 0.10; 4.67, 5.22, and 5.09 kg/d), and G:F (*P* = 0.31; 0.18, 0.19, and 0.20) did not differ among treatments for 0, 15, or 30% WDGS, respectively. There was a difference in DMI (*P* = 0.04) and there tended to be differences in ADG (*P* = 0.07) of steers fed WDGS and steers not fed WDGS. Average daily gain (*P* = 0.94), DMI (*P* = 0.35), and G:F (*P* = 0.95) did not differ among treatments for the first 14 d feeding period. No differences were observed for ADG (P = 0.80), DMI (P = 0.16), or G:F (P = 0.87) between steers fed WDGS and steers not fed WDGS for the first 14 d. Health data is presented in Table 3.4. Animals treated for BRD (*P* = 0.19; 58.33%, 43.33%, 43.33%) did not differ among treatments for 0, 15, or 30% WDGS, respectively. Animals treated for BRD (*P* = 0.07) tended to differ between steers fed WDGS and steers not fed WDGS.

Wet distillers grains plus solubles add palatability and conditioning to the feedlot diet, and have a higher energy value than DRC (Nuttelman et al., 2010), which means it would supply more energy to growing cattle. There is an extensive amount of literature of WDB and the effects they have on finishing cattle; however, literature on the effect of WDB in receiving diets is limited. In finishing diets, it has been shown that the replacement of corn up to 40% of diet DM as WDGS resulted in superior performance compared to cattle fed no WDGS (Bremer et al., 2011b). Dry matter intake, ADG, and F:G improves quadratically as WDGS inclusion level increases in the diet (Bremer et al., 2011b). Compared to corn in finishing diets, WDGS increases ADG and feed efficiency (Corrigan et al., 2009; Larson et al., 1993). However, this does not seem to be the case during the receiving period.

Leibovich et al. (2009) looked at the effects of SWDGS with and without DRC and SFC. From d 0 to 35 calves fed SWDGS had lower ADG ($P < 0.01$), DMI ($P < 0.01$), and feed efficiency ($P = 0.01$) than calves that were not fed any SWDGS. For the first 70 d of the trial, steers fed the SWDGS diets had lower ADG ($P < 0.01$), DMI ($P = 0.03$), and feed efficiency ($P < 0.01$). In a study done by Vasconcelos et al. (2007) who fed 200 steers increasing amounts of SWDGS, treatments consisted of 0, 5, 10, and 15% SWDGS and one treatment of 10% CWDGS, which replaced SFC in a high-concentrate diet. There was a linear decrease in ADG ($P = 0.03$) and DMI ($P = 0.01$) with increasing SWDGS over a 28 d and 56 d period. Feed efficiency did not differ ($P = 0.30$) for the 28 d period, but decreased linearly ($P = 0.001$) with increasing SWDGS over a 56 d period. There was no difference in ADG ($P \geq 0.30$) between the 10% SWDGS and 10% CWDGS treatments over 28 d or 56 d. Average daily gain and DMI were numerically lower over 28 and 56 d for the CWDGS diet compared to the control diet. Feed efficiency for the CWDGS diet was numerically greater for the 28 d period, but was lower across 56 d compared to the control diet. May et al. (2010) conducted an experiment using steers to compare SFC with CWDGS and SWDGS. Over a 35 d period, steers fed the SFC diet had greater DMI ($P = 0.04$) than those fed the WDGS-based diets and they found no differences in ADG. Steers fed the SFC diet had greater feed efficiency than the average of those fed WDGS diets for d 0 to 70 (*P* = 0.03). These results show that the inclusion of WDGS in the diet decreases the ADG and DMI of cattle. This differs from the present study, which found that the inclusion of WDGS increases ADG and DMI.

However, research done by May et al. (2011) fed steers a control diet with no WDGS; 15% WDGS with low, medium, or high levels of alfalfa hay; and 30% WDGS with low, medium, or high levels of alfalfa hay. They showed that there was a tendency for cattle fed 15 vs. 30% WDG to have greater ADG from d 0 to 35 (*P* = 0.093). Associated with the ADG response, there was a tendency for cattle fed 15 vs. 30% WDG to have greater DMI from d 0 to 35 (*P* = 0.059), and DMI was greater with 15% WDG from d 0 to 70 (*P* = 0.049). This is similar to the present study in that both experiments included 15 and 30% WDG in the diet and in the present study, ADG (*P* = 0.07) tended to be higher for steers fed WDGS and DMI (*P* = 0.04) increased when steers were fed WDGS.

Ham et al. (1994) conducted a growing calf trial with crossbred calves. Over a 56 d period calves fed a urea control diet with DRC gained less (*P* < 0.001) than cattle fed distillers byproducts. This is similar to the present experiment that had an increase in ADG from the diet that did not contain WDGS compared to the diets that included WDGS. In growing calf diets by Buckner et al. (2010), treatments consisted of 30 or 45% WDGS mixed with straw. The higher inclusion of WDGS resulted in greater ending BW (*P* < 0.01), ADG, and DMI (*P* = 0.05). Ending BW did not differ for the current study, but DMI (*P* = 0.04) increased and ADG (*P* = 0.07) tended to increase with the inclusion of WDGS in the diet.

In a study done by Larson et al. (1993) on crossbred yearling steers, treatments consisted of a control containing DRC and diets containing 5.2, 12.6, or 40.0% (DM basis) WDB. During the first 45 d, as the level of WDB increased from 0 to 40% of the diet (DM basis), DMI was affected both linearly ($P < 0.01$) and quadratically ($P = 0.04$). Yearlings fed 5.2 and 12.6% WDB consumed more DM than yearlings fed the control (quadratic, $P = 0.04$) or 40% WDB diets. However, ADG and efficiency were not significantly altered by WDB level.

Nuttelman et al. (2010) fed 15, 25, or 35% WDGS to crossbred steers to compare the energy value of WDGS to DRC in high forage diets. Cattle consuming WDGS gained more than cattle consuming DRC. Average daily gain increased with increasing levels of DRC and WDGS. Cattle consuming diets containing WDGS gained 0.1 kg more per day than cattle consuming diets with DRC ($P < 0.01$). Gain efficiency also was improved for cattle consuming WDGS ($P < 0.01$) due to greater ADG and constant DMI. Feed efficiency was improved with increased level of DRC and WDGS ($P < 0.01$). The feeding values of WDGS were 147, 149, and 142% the energy value of DRC when included in high forage diets at 15, 25, and 35% of the diet DM, respectively. This increased feeding value of WDGS in relation to DRC is attributed to the decreased negative associative effects on fiber digestion that are observed with increasing levels of starch, as well as the higher fat content of the WDGS.

## IMPLICATIONS

Byproduct usage from the ethanol industry has been continuing to grow and has additional benefits to a mixed ration. Improvements in ADG, DMI, and number of first treatments administered occurred when WDGS was included in receiving diets. Although some studies show that the inclusion of WDB during the receiving phase decreases cattle performance, this study suggests that SWDGS has a greater feeding value than DRC in receiving diets due to the improved performance in calves consuming the diets containing 15 and 30% WDGS. We conclude that the inclusion of WDGS in receiving diets improves health and performance of high-risk calves due to an increase in DMI. Based upon performance, SWDGS at 15 and 30% DM contains between 110 and 114% the energy value of DRC. Our research would indicate that at least 30% WDGS can be added to receiving rations based on DRC with improved health and performance.

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Table 3.1. Formulated ingredient composition of fed diets (DM basis).

| Ingredient | 0% WDGS | 15% WDGS | 30% WDGS |
|---|---|---|---|
| Dry-rolled corn | 45.41 | 40.25 | 25.25 |
| WDGS | 0.00 | 15.00 | 30.00 |
| Prairie hay | 30.00 | 30.00 | 30.00 |
| Alfalfa hay | 8.00 | 8.00 | 8.00 |
| Liquid suppl.[1] | 6.00 | 0.00 | 0.00 |
| Supplement | 10.59[2] | 6.75[3] | 6.75[4] |

[1] Westway Feed LLC, Tomball, TX.

[2] 0.01% Rumensin 90 (Elanco Animal Health, Indianapolis, IN), 7.63% soybean meal 47.7, 1.03% wheat midds, 0.19% urea, 0.37% potassium chloride, 1.06% limestone (38%), 0.24% salt, 0.001% manganous oxide, 0.02% zinc sulfate, 0.05% magnesium oxide, 0.004% vitamin A, and 0.002% vitamin E (50%).

[3] 0.01% Rumensin 90 (Elanco Animal Health, Indianapolis, IN), 3.18% corn dent no. 2, 1.04% wheat midds, 0.63% urea, 0.37% potassium chloride, 1.06%limestone (38%), 0.24% salt, 0.001% manganous oxide, 0.02% zinc sulfate, 0.05% magnesium oxide, 0.004% vitamin A, 0.002% vitamin E (50%), and 0.15% soybean meal 47.7.

[4] 0.01% Rumensin 90, (Elanco Animal Health, Indianapolis, IN), 3.33% corn dent no. 2, 1.03% wheat midds, 0.63% urea, 0.37% potassium chloride, 1.06% limestone (38%), 0.24% salt, 0.001% manganous oxide, 0.02% zinc sulfate, 0.05% magnesium oxide, 0.004% vitamin A, and 0.002% vitamin E (50%).

Table 3.2. Analyzed nutrient composition of fed diets (DM basis).

| Nutrient | 0% WDGS | 15% WDGS | 30% WDGS |
|---|---|---|---|
| NEm, Mcal/kg | 1.78 | 1.71 | 1.68 |
| NEg, Mcal/kg | 1.10 | 1.04 | 1.02 |
| TDN % | 81.83 | 78.99 | 76.91 |
| Fat | 4.29 | 4.31 | 5.26 |
| Crude fiber | 14.12 | 14.92 | 15.70 |
| ADF | 18.83 | 20.69 | 22.60 |
| NDF | 28.82 | 31.28 | 33.24 |
| eNDF | 54.03 | 52.21 | 47.73 |
| CP % | 14.00 | 14.00 | 17.15 |
| K % | 1.19 | 1.01 | 1.07 |
| Ca % | 0.77 | 0.75 | 0.78 |
| P % | 0.30 | 0.32 | 0.40 |
| Mg % | 0.25 | 0.26 | 0.29 |
| S % | 0.21 | 0.22 | 0.30 |
| Co, mg/kg | 0.09 | 0.11 | 0.13 |
| Cu, mg/kg | 9.6 | 6.4 | 6.9 |
| Fe, mg/kg | 101.6 | 87.4 | 100.4 |
| Mn, mg/kg | 55.1 | 57.3 | 63.7 |
| Se, mg/kg | 0.12 | 0.16 | 0.20 |
| Zn, mg/kg | 90.9 | 93.5 | 99.0 |

Table 3.3. The effects of treatment on feedlot performance.

| Item | 0% WDGS[1] | 15% WDGS | 30% WDGS | SEM | P-value TRT | P-value 0% vs. WDGS[1] |
|---|---|---|---|---|---|---|
| Pens | 10 | 10 | 10 | - | - | - |
| Total head | 60 | 60 | 60 | - | - | - |
| Initial BW, kg | 213 | 214 | 211 | 2 | 0.54 | 0.81 |
| Day 14 BW, kg | 219 | 220 | 218 | 2 | 0.73 | 0.94 |
| Final BW, kg | 248 | 256 | 254 | 4 | 0.31 | 0.15 |
| Day 0 to14 | | | | | | |
| ADG, kg/d | 0.46 | 0.47 | 0.50 | 0.09 | 0.94 | 0.80 |
| DMI, kg/d | 3.23 | 3.58 | 3.53 | 0.15 | 0.35 | 0.16 |
| G:F, kg/kg | 0.13 | 0.13 | 0.14 | 0.02 | 0.95 | 0.87 |
| Day 0 to 42 | | | | | | |
| ADG, kg/d | 0.84 | 1.01 | 1.02 | 0.07 | 0.19 | 0.07 |
| DMI, kg/d | 4.67 | 5.22 | 5.09 | 0.18 | 0.10 | 0.04 |
| G:F, kg/kg | 0.18 | 0.19 | 0.20 | 0.01 | 0.31 | 0.15 |

[1] 0% WDGS vs 15 & 30% WDGS.

Table 3.4. The effects of treatment on morbidity.

| Item | 0% WDGS[1] | 15% WDGS | 30% WDGS | P-value TRT | P-value 0% vs. WDGS[2] |
|---|---|---|---|---|---|
| Pens | 10 | 10 | 10 | - | - |
| Total head | 57 | 60 | 60 | - | - |
| Day 0-42 | | | | | |
| Treated once, % pen | 58.33 | 43.33 | 43.33 | 0.19 | 0.07 |
| Treated twice, % once | 42.86 | 26.92 | 42.31 | 0.40 | 0.43 |
| Treated thrice, % twice | 40.97 | 28.14 | 17.30 | 0.47 | 0.28 |
| Animals treated, % pen | 66.67 | 51.85 | 59.26 | 0.39 | 0.26 |

[1] 3 steers were deemed chronic and removed from the 0% WDGS treatment.

[2] 0% WDGS vs 15% and 30% WDGS.

# CHAPTER IV

## EFFECT OF ENERGY DENSITY IN HIGH BYPRODUCT DIETS ON HEALTH AND RECEIVING PERFORMANCE OF CALVES

ABSTRACT: The objective of this experiment was to determine the effects of altering hay in high corn product and SweetBran® level diets on the health and performance of receiving calves. In a randomized complete block design experiment, 476 crossbred calves (initial BW = 231 ± 4 kg) were blocked by source and arrival BW before being randomly assigned to 1 of 4 receiving diets that were fed for 49 d. Experimental treatments consisted of: a base low-energy diet containing 20.0% dry-rolled corn, 14.8% prairie hay, 59.1% Sweet Bran® (Cargill Animal Nutrition, Minneapolis, MN) and 6.15% dry supplement (LE-DRC); the base diet with wet distillers grains plus solubles (WDGS) replacing corn (LE-WDGS); 20% WDGS replacing a portion of hay and Sweet Bran® from the base diet(ME); or inclusion of 40% corn and 20% WDGS replacing a portion of the hay and Sweet Bran® (HE). On arrival, calves were weighed, vaccinated, and dewormed, but were not implanted. Bulls were surgically castrated and annotated for equal distribution across treatments. Performance data were analyzed using PROC MIXED in SAS 9.3 (SAS Institute, Cary, N.C.) and health date were analyzed using PROC MIXED, but using arrival group and block as random variables. Contrasts were evaluated to compare the two low energy diets and the linear and quadratic effects of energy level. When LE diets were combined, there was a linear increase in total number of treatments for BRD (*P* = 0.05) with increasing energy level. There were no differences (*P* > 0.10) in overall performance between the Low-energy/DRC and Low-energy/WDGS diets. There was no difference (*P* = 0.75) in DMI, but as dietary energy increased, there was a linear increase in ADG (*P* = 0.03) and feed efficiency (*P* < 0.01). Similar to previous experiments, it appears that ADG and efficiency are improved with increasing energy density in diets for receiving calves, but negatively impact health even in high byproduct diets.

Key Words: energy, wet distillers grains plus solubles, high-risk calves, performance, cattle, health

# INTRODUCTION

Receiving diets must provide adequate energy, protein, vitamins, and minerals for calves to stay healthy and grow. If the diet is not readily acceptable to the calves, feed intake will be low, weight loss may occur, and critical nutrients may become deficient in the calves. This can be detrimental to both animal health and productivity (Fluharty and Loerch, 1996).

High levels of by-products are included in cattle's diets because they are utilized very efficiently by ruminants (Klopfenstein et al., 2008). Lower quality roughages can be used in feedlot diets containing wet distillers grains plus solubles (WDGS) and wet corn gluten feed (WCGF) because of the protein, moisture, and physical characteristics of the byproducts. Protein in byproducts reduces the need for protein in the roughages. Distillers (dry or wet) have been reported to have a high-energy value compared to corn in forage-based diets (Ahern et al., 2011). Compared to DRC in a forage-based diet, the energy value of WDGS numerically increases the ADG of cattle (Nuttelman et al., 2009). The low level of starch, energy density of fat, undegradable protein, and crude fiber are the possible reasons contributing to greater energy value compared to corn as a supplement (Ahern et al., 2011). The inclusion of WCGF in finishing diets has been reported to decrease incidence and severity of acidosis, likely because of the addition of highly digestible fiber to high-starch diets (Krehbiel et al., 1995).

High-energy diets have resulted in improved feed efficiency vs. low-energy diets (Fluharty et al., 1994). As the level of energy increases in the diet, final BW, G:F, and ADG increase linearly (Ahern et al., 2011). Cattle consuming WDGS or dried distillers grains plus solubles (DDGS) at 40% of diet gain faster and more efficiently than cattle fed DRC (Ham et al., 1994). Similar to previous experiments, it appears that ADG and efficiency are improved with increasing energy density in diets for receiving calves, but health is negatively impacted.

## MATERIALS & METHODS

### *Treatments*

Four hundred seventy-six crossbred calves (231 ± 4 kg) were received in four groups and randomly assigned to one of four treatments: a base diet containing 20.0% dry-rolled corn, 14.8% prairie hay, 59.1% Sweet Bran® and 6.15% dry supplement; the base diet with WDGS replacing corn; 20% WDGS replacing a portion of hay and Sweet Bran® from the base diet; or inclusion of 40% corn and 20% WDGS replacing a portion of the hay and Sweet Bran® (Table 4.1). Treatments were randomly assigned to each pen before the calves arrived. The first 384 calves were randomly assigned to 16 pens and the last 92 calves were randomly assigned 23 hd to 4 pens.

### *Feeding Management*

Treatment rations were fed twice daily at 0700 and 1300 h. Prairie hay was fed at 1 kg per head for the first seven days. Bunks were cleaned to remove manure, hair, etc. each day before feeding. Bunks were managed to contain 0.5 kg/hd each day for the first 14 days and traces of feed for the remainder of the study. Animals were housed in open lot dirt floor pens that were approximately 12.2 × 30.5 m. Bunks were 12.2 m in length and cattle had ad libitum access to water via an automatic water basin (J360-F, Johnson Concrete, Hastings, NE) located along the fence line and shared between 2 adjacent pens.

Ration samples were collected once per week and dried in a forced air oven for 48 h at 60°C to determine dry matter. Ration samples were composited gravimetrically and analyzed at a commercial lab (Servi-Tech, Inc. Dodge City, KS) for nutrient composition.

Rations were formulated to meet or exceed NRC requirements. A ground corn and wheat-midd based supplement was included in the ration to provide all necessary vitamins, minerals, and ionophores. The analyzed values of crude protein, ADF, NDF, and the macro minerals were comparable to the formulated values (Table 4.2). The analyzed micro minerals (Zn, Fe, and Mn); however, differed from the formulated values, possibly due to sampling or compositing error. The supplement for this experiment contained 0.16% Rumensin-90 (Elanco Animal Health, Indianapolis, IN), 28.24% limestone (38%), 6.50% potassium chloride, 4.07% salt, 40.60% ground corn, 19.53% wheat midds, 0.10% copper sulfate, 0.08% manganese oxide, 0.04% selenium (0.6%), 0.51% zinc sulfate, 0.12% vitamin A (30,000 IU/g), and 0.04% vitamin E (50%). The analyzed composition of the supplement was comparable to the formulated values.

*Cattle Management*

Calves were delivered to the WSBRC in Stillwater, OK, unloaded, individually weighed through the chute and received individual identification with both a unique visual and an electronic identification tag. An individual physical description was obtained indicating those that were bulls, had horns, etc. Calves were then allowed access to ad-libitum hay and water during a 24 to 72 h rest period prior to processing. At time of initial processing, cattle were individually weighed and received vaccination against IBR, PI3, BRSV, and BVD type I and II (Express 5; Boehringer Ingelheim, St. Joseph, MO), Cl chauvoei, Cl septicum, Cl novyi, Cl sordellii, Cl perfringens Types C and D (Caliber

7; Boehringer Ingelheim, St. Joseph, MO), and external parasites (Ivomec Plus; Merial Animal Health, Duluth, GA). Calves did not receive implants. Bulls were surgically castrated using a Newberry Knife, and equally stratified across treatments. Horns were tipped.

Calves were visually appraised for signs of bovine respiratory disease (BRD) according to the WSBRC protocol based upon the DART system (Pharmacia Upjohn Animal Health, Kalamazoo, MI; Step et al. 2008) using a clinical assessment score twice per d for the first 14 d, and then once/d thereafter (Holland et al. 2010). Calves noted as needing examination were pulled and a rectal temperature obtained (GL M-500, GLA Agricultural Electronics, San Luis Obispo, CA). If the rectal temperature was ≥ 40°C, treatment was administered. Calves noted as a severity score 3 or higher were treated according to protocol regardless of rectal temperature. A maximum of 3 antimicrobial treatments were allowed, and doses were calculated by rounding the BW to the nearest 11 kg. All antimicrobials were administered via a subcutaneous injection in the neck following Beef Quality Assurance Guidelines (NCBA, 2001). Calves indicated for treatment were treated with 10 mg of tilmocosin/kg of BW (Micotil, Elanco, Greenfield, IN). If determined to be affected by BRD after a 5 d moratorium, calves were administered 10 mg of enrofloxacin/kg of BW (Baytril 100, Bayer Animal Health, Shawnee Mission, KS). A 2 d moratorium was observed before calves were evaluated for treatment with the final treatment of 6.6 mg of ceftiofur crystalline free acid/kg of BW (Excede, Pfizer Animal Health, New York, NY). Calves that were deemed unsuitable to adequately perform in their home pen (BRD, lame, buller, etc.) were removed from the experiment. Calves that died during the study were necropsied and cause of death was determined. All calves that died or were removed due to BRD, lameness, etc. were removed from the performance analysis. Five calves were removed from this study (1 cripple, 2 chronics, 1 foot rot, and 1 broken back) and were not included in the data analysis.

Calf weights were recorded on d 28 and 49 with a 2% shrink applied for calculation of performance. Orts were gathered and weighed back, a dry-matter was determined and residual feed removed from total feed delivered for determination of DMI. Performance was calculated on a deads and removals excluded basis. An average dry-matter was calculated for the feeding period and actual DMI consumption was calculated at the end of the study by dividing total pounds of feed dry matter consumed by total head days of a pen. For DMI calculations, any animal that was removed from the study due to poor performance, feed for that animal was removed at 1 × $NE_m$. Net energy recovered was calculated using animal performance and the NRC (2000).

*Statistical Analyses*

Pen was the experimental unit in a randomized complete block experimental design. Performance data were analyzed using PROC MIXED using arrival group and block as random variables and initial BW as a covariate. Health data were analyzed using PROC GLIMMIX in SAS 9.3 (SAS Institute, Cary, N.C.) using block and arrival group as random variables. Contrasts were evaluated to compare the two low energy diets and the linear and quadratic effects of energy level. Contrasts were considered significant at $P < 0.05$ when the main treatment effect was $P < 0.10$. No differences between Low-E treatments were found, so they were combined for linear and quadratic contrasts. Calves that were removed from the trial were not included in the performance or health analysis.

During the randomization procedure, weights for the second weight block were copied and pasted incorrectly within a spreadsheet and some cattle were inadvertently included in the incorrect pen. Regrettably this error was not discovered until after the study and data from the replicate could not be utilized.

## RESULTS AND DISSCUSION

The number of animals treated at least once for BRD (n = 87) were not different (*P* = 0.13) among treatments, but there was a linear increase in treatments with increasing energy level. There was no difference (*P* = 0.75) (Table 4.3) in DMI, but as dietary energy increased there was a linear increase in ADG (*P* = 0.03) and feed efficiency (*P* < 0.01). Dry matter intake for d 29 to 49 decreased linearly as energy levels increased (*P* = 0.01). Feed efficiency (*P* = 0.01) and ADG (*P* = 0.01) for d 29 to 49 increased linearly with increasing levels of energy.

Calculated net energy concentrations of the diets increased linearly (*P* < 0.01) across the diets. The overall NEm and NEg recovered from the diets were greatest for the high-energy treatment (1.91 and 1.26 Mcal/kg DM, respectively) and lowest for the low-energy/WDGS treatment (1.79 and 1.16 Mcal/kg DM, respectively).

Previous research by Lofgreen et al. (1975) and Pritchard and Mendez (1990), showed that as dietary concentrate (energy) levels increased, DMI increased, which is contrary to the current study's results that showed no difference in DMI. However, similar to Fluharty et al. (1994), who reported that higher energy diets resulted in an increased (*P* < 0.05) feed efficiency compared with lower energy diets, the current study also showed increasing feed efficiency with increasing energy in the diet. Lower energy recovery for WDGS compared with DRC is contrary to the results of Larson et al. (1993)

who found that when fed at 40% of diet DM, wet distiller's byproducts averaged 28% more net energy than corn when fed to calves. Al-Suwaiegh et al. (2002) found that wet sorghum distiller's grain's calculated NEg value was 8.6% greater than that of DRC.

McCoy et al. (1998), performed two receiving studies that compared energy source (DRC or WCGF) and protein supplement. Supplemental escape protein (EP) was provided by an 80% feather meal (FTH): 20% ring-dried blood meal (BM) blend (CP basis). For receiving trial 1, calves fed WCGF had lower DMI ($P < 0.01$) and gained slower ($P < 0.05$) than calves fed DRC. Feed efficiency was not affected ($P > 0.15$) by energy source, but was improved ($P < 0.10$) with EP supplementation. The metabolizable protein (MP) supply for calves fed DRC was higher ($P < 0.01$) than that for calves fed WCGF and higher ($P < 0.01$) for calves fed supplemental EP than for calves not fed supplemental EP. Less morbidity was observed in calves fed DRC ($P < 0.10$) than in calves fed WCGF and mortality was not affected ($P > 0.15$) by energy source or protein supplement.

For their second receiving trial (McCoy et al., 1998), calves fed WCGF had lower DMI ($P < 0.01$), gained similarly ($P > 0.15$), and were more efficient ($P < 0.10$) than calves fed DRC. The MP supply of calves fed DRC was higher ($P < 0.01$) than that of calves fed WCGF and higher ($P < 0.05$) for calves fed supplemental EP than for calves not fed supplemental EP. A negative correlation ($P < 0.01$) was observed between MP supply and morbidity, indicating that increased MP supply may improve health. Dietary NEg was higher ($P < 0.05$) for WCGF diets than for DRC diets.

Ham et al. (1995) assigned crossbred steer calves to one of five dietary treatments with varying levels of DRC and WCGF. They found that calves fed a 49% WCGF and

50% alfalfa hay diet gained 14% faster (P < 0.10) and 11% more efficiently (P < 0.10) than calves fed the two control diets that contained 44% DRC with 50% alfalfa hay and 33% DRC with 33% alfalfa hay and 33% CS. They found that increasing the level of WCGF from 49 to 65% increased ADG (P < 0.10) and feed efficiency (P < 0.10), but DMI was not affected (P > 0.10). This is contrary to the current study where there was no difference ($P = 0.75$) in DMI, but ADG ($P = 0.03$) and feed efficiency ($P < 0.01$) increased when WCGF was decreased and DRC was increased.

## IMPLICATIONS

This study suggests that diets containing DRC that is fed alongside WCGF improves efficiency and has a higher energy content compared to diets containing WDGS and WCGF. This is contrary to previous experiments that suggest that WDGS have a higher energy content than DRC. Energy density in the diet seems to have a quadratic effect on the health of receiving calves. Distillers byproducts and corn gluten feed are excellent sources of energy and protein for calves. Dry matter intake was not affected by energy density, but similar to previous experiments, it appears that ADG and efficiency are improved with increasing energy density in diets for receiving calves. Additional research is needed for determining the effects of altering levels of energy with grain byproducts on the health and performance of calves during the receiving phase.

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Table 4.1. Composition of diets fed to newly received calves (%DM basis)

| Ingredient | Low-E/Corn | Low-E/WDGS | Medium Energy | High Energy |
|---|---|---|---|---|
| Rolled corn | 20.00 | 0.00 | 20.00 | 40.00 |
| Prairie hay | 14.77 | 14.77 | 10.77 | 6.77 |
| WDGS | 0.00 | 20.00 | 20.00 | 20.00 |
| Sweet Bran®[1] | 59.08 | 59.08 | 43.08 | 27.08 |
| Supplement[2] | 6.15 | 6.15 | 6.15 | 6.15 |

[1] Cargill Nutrition, Minneapolis, MN.

[2] 0.16% Rumensin-90 (Elanco Animal Health, Indianapolis, IN), 28.24% limestone (38%), 6.50% potassium chloride, 4.07% salt, 40.60% ground corn, 19.53% wheat midds, 0.10% copper sulfate, 0.08% manganese oxide, 0.04% selenium (0.6%), 0.51% zinc sulfate, 0.12% vitamin A (30,000 IU/g), and 0.04% vitamin E (50%).

Table 4.2. Analyzed nutrient composition of diets fed to newly received calves (DM basis)

| Nutrient | Low-E/Corn | Low-E/WDGS | Medium energy | High energy |
|---|---|---|---|---|
| Crude protein, % | 16.80 | 21.03 | 19.33 | 16.97 |
| ADF, % | 14.60 | 16.67 | 12.93 | 10.00 |
| NDF, % | 35.17 | 38.27 | 32.23 | 25.53 |
| Crude fat, % | 3.37 | 4.67 | 4.73 | 4.47 |
| TDN, % | 82.47 | 76.40 | 87.03 | 89.30 |
| NEm, Mcal/kg | 0.42 | 0.38 | 0.44 | 0.46 |
| NEg, Mcal/kg | 0.28 | 0.25 | 0.30 | 0.32 |
| Ca, % | 0.82 | 0.91 | 0.64 | 0.65 |
| P, % | 0.77 | 0.88 | 0.75 | 0.59 |
| Mg, % | 0.30 | 0.35 | 0.30 | 0.24 |
| K, % | 1.33 | 1.48 | 1.22 | 0.98 |
| S, % | 0.31 | 0.45 | 0.39 | 0.33 |
| Na, % | 0.26 | 0.35 | 0.27 | 0.23 |
| Zn, mg/kg | 158.00 | 162.33 | 136.00 | 138.00 |
| Fe, mg/kg | 149.67 | 210.33 | 171.33 | 134.33 |
| Mn, mg/kg | 61.33 | 77.00 | 51.33 | 52.33 |
| Cu, mg/kg | 18.33 | 25.33 | 18.00 | 18.00 |

Table 4.3. The effects of treatment on feedlot performance

| | | | | | | P-value | | | |
|---|---|---|---|---|---|---|---|---|---|
| Item | Low-E /DRC | Low-E /WDGS | Medium energy | High energy | SEM | Trt | Quad | Linear | 1 vs. 2[1] |
| Pens | 5 | 5 | 5 | 5 | - | - | - | - | - |
| Total head | 117 | 118 | 118 | 119 | - | - | - | - | - |
| Intl BW, kg | 231 | 231 | 231 | 231 | 64.02 | 0.74 | 0.86 | 0.44 | 0.95 |
| Day 28 BW, kg | 279 | 277 | 277 | 281 | 21.27 | 0.22 | 0.25 | 0.14 | 0.41 |
| Final BW, kg | 315 | 311 | 316 | 319 | 22.65 | 0.08 | 0.94 | 0.03 | 0.19 |
| Day 0 to 28 | | | | | | | | | |
| ADG, kg/d | 1.52 | 1.45 | 1.46 | 1.60 | 0.76 | 0.31 | - | 0.14 | 0.41 |
| DMI, kg/d | 7.01 | 6.89 | 6.90 | 7.11 | 2.38 | 0.45 | - | 0.30 | 0.50 |
| G:F, kg/kg | 0.219 | 0.216 | 0.216 | 0.226 | 0.013 | 0.47 | 0.86 | 0.29 | 0.78 |
| NEm, Mcal/ kg DM | 1.95 | 1.92 | 1.94 | 1.98 | 1.62 | 0.73 | 0.25 | 0.36 | 0.55 |
| NEg, Mcal/ kg DM | 1.30 | 1.28 | 1.29 | 1.33 | 1.42 | 0.73 | 0.94 | 0.36 | 0.55 |
| Day 29 to 49 | | | | | | | | | |
| ADG, kg/d | 1.72 | 1.64 | 1.87 | 1.81 | 0.20 | 0.17 | - | 0.22 | 0.50 |
| DMI, kg/d | 9.11 | 8.63 | 8.80 | 8.40 | 1.72 | 0.03 | - | 0.01 | <0.01 |
| G:F, kg/kg | 0.191 | 0.188 | 0.214 | 0.219 | 0.017 | 0.06 | 0.86 | 0.03 | 0.85 |
| NEm, Mcal/ kg DM | 1.81 | 1.81 | 1.95 | 2.01 | 2.87 | 0.06 | 0.25 | 0.01 | 0.94 |
| NEg, Mcal/ kg DM | 1.17 | 1.18 | 1.30 | 1.35 | 2.51 | 0.06 | 0.94 | 0.01 | 0.94 |
| Day 0 to 49 | | | | | | | | | |
| ADG, kg/d | 1.61 | 1.53 | 1.63 | 1.69 | 0.46 | 0.08 | - | 0.03 | 0.20 |
| DMI, kg/d | 7.90 | 7.63 | 7.71 | 7.66 | 2.12 | 0.75 | - | 0.46 | 0.11 |
| G:F, kg/kg | 0.206 | 0.202 | 0.215 | 0.224 | 0.004 | <0.01 | 0.86 | <0.01 | 0.58 |
| NEm, Mcal/ kg DM | 1.81 | 1.79 | 1.86 | 1.91 | 1.15 | 0.02 | 0.25 | <0.01 | 0.65 |
| NEg, Mcal/ kg DM | 1.18 | 1.16 | 1.22 | 1.26 | 1.01 | 0.02 | 0.94 | <0.01 | 0.65 |

[1] Low-E/DRC vs. Low-E/WDGS.

Table 4.4. Effects of treatment on morbidity[1]

| Item | Low-E / DRC | Low-E / WDGS | Medium energy | High energy | *P* - value Trt | 1 vs. 2[2] | Linear | Quad |
|---|---|---|---|---|---|---|---|---|
| Pens | 6 | 6 | 6 | 6 | - | - | - | - |
| Total head | 117 | 118 | 118 | 119 | - | - | - | - |
| Treated once, % pen[3] | 3.44 | 4.52 | 8.68 | 2.61 | 0.10 | 0.60 | 0.37 | 0.04 |
| Animals treated, % pen[4] | 2.38 | 1.53 | 4.23 | 7.38 | 0.13 | 0.65 | 0.05 | 0.86 |
| Removed | 2[5] | 2[6] | 1[7] | 0 | 0.75 | 0.99 | 0.99 | 0.47 |

[1] Block 2 excluded from data.

[2] Low-E/DRC vs. Low-E/WDGS.

[3] Only includes those animals that received 1 antimicrobial treatment.

[4] Includes all antimicrobials administered.

[5] 2 chronics.

[6] 1 foot rot and 1 broken back.

[7] 1 cripple.

# APPPENDIX

All procedures involving live animals were approved by the
Oklahoma State University Institutional Animal Care and Use Committee.

# VITA

Joseph James Wagner

Candidate for the Degree of

Master of Science

Thesis: THE EFFECTS OF WET DISTILLERS GRAINS PLUS SOLUBLES AND ENERGY OF THE HEALTH AND PERFORMANCE OF RECEIVING CALVES

Major Field: Animal Science

Biographical:

Education:

Completed the requirements for the Master of Science in Animal Science at Oklahoma State University, Stillwater, Oklahoma in May, 2012.

Completed the requirements for the Bachelor of Science in Biology at Oklahoma Panhandle State University, Goodwell, OK in 2009.

Experience:

Graduate Research Assistant - Willard Sparks Beef Research Center (2010 – present)

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Summer laborer – Southeast Colorado Research Center, Colorado State University, Lamar, CO (2005 – 2009)

Summer laborer – Continental Beef Research of ContiBeef LLC, Lamar, CO (2002 – 2005)

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Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: THE EFFECTS OF WET DISTILLERS GRAINS AND ENERGY OF THE HEALTH AND PERFORMANCE OF RECEIVING CALVES

Pages in Study: 71 Candidate for the Degree of Master of Science

Major Field: Animal Science

A randomized complete block design experiment utilizing 180 high-risk crossbred steers (initial BW = 212 ± 2 kg) was conducted to evaluate the effects of including wet distillers grains plus solubles (WDGS) in a 62% concentrate receiving diet on steer performance and health over a 42-d period. Experimental treatments consisted of receiving diets with inclusion of 0%, 15%, or 30% WDGS replacing dry-rolled corn, liquid supplement and a portion of dry supplement. Average daily gain, DMI, G:F, and animals treated for BRD ($P > 0.10$) did not differ among treatments for 0, 15, or 30% WDGS, respectively. Dry matter intake differed ($P = 0.04$; 4.67 vs. 5.16 kg/d, respectively) differed and there tended to be differences ($P = 0.07$; 0.46 vs. 0.49 kg/d, respectively) in ADG between control steers and those fed WDGS. Feeding WDGS receiving diets to high-risk calves did not negatively impact animal health or performance. A second experiment was conducted to determine the effects of altering hay, corn, Sweet Bran$^{®}$ levels in high byproduct diets on the health and performance of receiving calves. In a randomized complete block design experiment, 476 crossbred calves (initial BW = 231 ± 4 kg) were blocked by source and arrival BW before being randomly assigned to 1 of 4 receiving diet treatments, which were fed for 49 d. Experimental treatments consisted of: a base diet containing 20.0% dry-rolled corn, 14.8% prairie hay, 59.1% Sweet Bran$^{®}$ and 6.15% dry supplement; the base diet with WDGS replacing corn; 20% WDGS replacing a portion of hay and Sweet Bran$^{®}$ from the base diet; or inclusion of 40% corn and 20% WDGS replacing a portion of the hay and Sweet Bran$^{®}$. There were no differences ($P > 0.10$) in overall performance or health between the low concentrate diets. Percentage of calves treated at least once were not different ($P = 0.13$) among treatments. When low concentrate diets were combined there was a linear increase ($P < 0.05$) in antimicrobial treatments with increasing concentrate level. There was no difference ($P = 0.75$) in DMI, but as diet concentrate increased there was a linear increase in ADG ($P = 0.03$) and feed efficiency ($P < 0.01$). Similar to previous experiments, it appears that ADG and efficiency are improved with increasing energy density in diets for receiving calves, but health is negatively impacted.

ADVISER'S APPROVAL: Dr. Chris Richards, Ph.D.