Final Report

Identification

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Public Summary of Outcomes and Benefits to Canada

This project was designed to demonstrate to cattle producers that canola meal is equal to or superior to soybean meal as a protein supplement for ruminant production systems. Our objectives were to compare the performance of growing and finishing beef cattle fed canola meal as a protein supplement relative to those fed soybean meal with or without WDDGS; to measure rumen degradability characteristics of canola meal relative to soybean meal and WDDGS and to determine if canola meal supplementation either alone or in combination with WDDGS improves rumen fermentation, microbial protein synthesis and intestinal amino acid supply in growing beef cattle relative to those fed soybean meal based diets. Such comparisons are important as soybean meal is traditionally viewed by ruminant nutritionists and cattle producers throughout North America and globally as the protein supplement of choice for beef and dairy cattle. The results of the growing trial showed that cattle fed canola meal exhibited similar performance to those fed soybean meal with the poorest performance observed with cattle fed a combination of soybean meal and WDDGS. In a subsequent growing/finishing trial, performance was again similar between cattle fed canola meal versus those fed soybean meal. In both trials, soybean meal fed cattle had numerically the highest feed cost of gain. With respect to carcass traits, soybean meal and WDDGS fed cattle had the poorest fat deposition compared to cattle fed canola meal and WDDGS. In terms of impact on rumen fermentation and nutrient digestibility, heifers fed canola meal had the highest ($P < 0.05$) dry matter, organic matter, and nitrogen apparently and truly digested in the rumen compared to heifers fed soybean meal and inclusion of WDDGS tended to decrease N truly digested in the rumen. There were no treatment differences noted in dry matter, organic matter, crude protein, acid detergent fibre, or neutral detergent fibre digestibility. The results of all three trials indicate that canola meal is at least equal to soybean meal as a protein supplement for feedlot cattle and that the inclusion of WDDGS did not improve feedlot performance, rumen fermentation, or nutrient digestibility. In summary, based on performance results of this research, canola meal can be considered equal to soybean meal as a protein supplement for beef cattle and based on current economics would be the protein supplement of choice for beef producers.

Progress Towards Objectives/Milestones

To what extent were the objectives of the grant achieved? Rate your answer on a scale from 1 to 7.

Not at all			Somewhat		To a great extent	
○ 1	○ 2	○ 3	○ 4	○ 5	● 6	○ 7

To establish canola meal as the premier protein supplement for beef cattle, a series of trials were carried out to evaluate the value of canola meal in growing/finishing cattle diets relative to other common protein supplements such as soybean meal and wheat dried distiller's grains with solubles (DDGS). Our hypothesis was that due to its palatability, favorable balance of amino acids, and high level of rumen escape amino acids, CM will prove at least as good a protein supplement as SBM for growing and finishing beef cattle and that additional rumen degradable protein (RUP), provided by WDDGS will prove beneficial to growth during backgrounding.

The specific objectives of the research were to:

1. To compare the performance of growing beef cattle fed CM as a protein supplement relative to those fed SBM with or without WDDGS.
2. To determine the effect of CM vs SBM or WDDGS for finishing cattle on performance and carcass quality.
3. To measure in situ rumen degradability characteristics of CM relative to SBM and WDDGS.
4. To determine if CM supplementation either alone or in combination with a RUP source, provided by WDDGS, improves rumen fermentation, microbial protein synthesis and intestinal amino acid supply in growing beef cattle.

Research Progress

To address our hypothesis and objectives, four trials were carried out. The first two focused on the value of canola meal relative to soybean when fed with or without wheat DDGS in diets for backgrounding and finishing cattle with a specific focus on performance and carcass quality. In addition an in situ degradability trial was carried out to evaluate the rumen degradability of CM relative to SBM and wheat DDGS. Finally a metabolism trial that focused on site and extent of nutrient utilization in cannulated beef heifers was run. The following details our results.

Performance Trials:

Two trials were conducted to evaluate the performance and carcass characteristics of backgrounding and finishing cattle fed canola meal (**CM**) versus soybean meal (**SBM**) as a protein supplement with or without wheat dried distillers' grains with solubles (**WDDGS**). Trial 1 was a 95-d backgrounding program in which 398 steer calves (288 ± 17.6 kg; mean ± SD) were randomly assigned to one of 12 pens and fed one of four diets with either CM, SBM, CM+WDDGS, or SBM+WDDGS as a protein supplement. The barley silage, barley grain-based diets were formulated to 13.5% CP, and 1.52 and 0.92 Mcal kg^{-1} NE_m and NE_g, respectively. Trial 2 utilized 300 head (305 ± 18.4kg) assigned to 25 pens for a 61-d backgrounding and 147-d finishing program. Backgrounding diets were identical to Trial 1 with the addition of a fifth treatment (WDDGS). The basal finishing diet was barley grain-based and formulated to 13% CP, and 1.95 and 1.30 Mcal kg^{-1} NE_m and NE_g, respectively. The five dietary treatments were CM, SBM, WDDGS, CM+WDDGS, or SBM+WDDGS as a protein supplement. Performance data were analyzed as a completely randomized design using pen as the experimental unit. Quality and yield grades were analyzed using GLIMMIX with a binomial error structure and logit data transformation. In Trial 1, there were no differences between treatments for final BW (420.7 ± 1.8 kg; mean ± SE; $P = 0.30$), or gain-to-feed (G:F) (0.16 ± 0.003; $P = 0.60$). Cattle fed SBM had greater ADG ($P < 0.05$) relative to cattle fed SBM+WDDGS (1.45 ± 0.04 kg vs. 1.32 ± 0.03

kg) but also numerically had the highest feed cost of gain ($1.03 kg^{-1}) compared to the other three treatments. In Trial 2, no treatment differences ($P > 0.22$) were detected for overall ADG (1.65 ± 0.01 kg), DMI (9.77 ± 0.07 kg), or G:F (0.17 ± 0.001). Cattle fed SBM+WDDGS had the least subcutaneous fat depth relative as compared to cattle fed CM+WDDGS (1.17 ± 0.06 cm vs. 1.46 ± 0.05 cm; $P = 0.02$) and the poorest marbling score relative to cattle fed WDDGS (398.75 ± 15.19 vs. 440.10 ± 8.20; $P = 0.05$). There was a tendency ($P = 0.09$) for greater proportion of AAA carcasses with the WDDGS treatment (66.1 ± 6.2%) while SBM+WDDGS had the least (41.4 ± 6.5%). Cattle fed WDDGS in combination with CM and SBM had better fatty acid profiles, with higher concentrations of C18:3 n-3 (0.24 ± 0.01% FAME vs. 0.21 ± 0.01% FAME), *t*11-18:1 (0.45 ± 0.02% FAME vs. 0.29 ± 0.02% FAME), and *c*7-16:1 (0.17 ± 0.01% FAME vs. 0.14 ± 0.01% FAME) and lower concentrations of *t*10-18:1 (1.03 ± 0.14% FAME vs. 1.32 ± 0.19% FAME) and C17:0 (1.03 ± 0.04% FAME vs. 1.15 ± 0.02% FAME) compared to those fed just CM or SBM. These results indicate that CM is equal to SBM as a protein supplement for backgrounding and finishing cattle and that provision of WDDGS as a source of rumen degradable protein did not benefit performance, although it did improve the feed cost of gain. The combination of SBM+WDDGS negatively influenced energy partitioning to carcass fat deposition.

In Situ Rumen Degradability:

Rumen incubations (N = 3 replicates) of CM, SBM and WDDGS samples in nylon bags were performed according to the 'gradual in all out' schedule, with bags incubated for 0h, 2h, 4h, 8h, 12h, 24h, 48h. Following incubation, bags were removed from the rumen and rinsed in cold water to remove excess ruminal contents and then thoroughly washed in cold water. The bags were then dried at 55°C for 48 h in a forced air oven. After drying, the bags were exposed to room temperature and humidity for 24 h before being weighed. The rumen degradation characteristics analyzed included the soluble (S, %), potentially degradable (D, %) and the degradable fractions (U, %), the rate of degradation (Kd, $\%h^{-1}$), and lag time (T0, h). These were estimated using a non-linear iterative regression model (SAS Institute Inc. Cary, NC) Effective degradability (ED, %) of dry matter and crude protein for each protein supplement were calculated with the passage rate assumed to be 6% h^{-1}. The results indicated that in regard to dry matter disappearance, CM had the lowest S fraction (18.5 ± 0.5%; $P < 0.05$) compared to SBM (29.9 ± 0.4%) and WDDGS (39.3 ± 0.2%) and a higher D fraction than WDDGS (64.1 ± 1.3% vs. 48.3 ± 0.6%). Soybean meal had the lowest U fraction (1.5 ± 1.5%; $P < 0.05$) compared to CM (17.4 ± 1.3%) and WDDGS (12.4 ± 0.7%). This led to SBM having the highest (78.1 ± 3.9%; $P < 0.05$) effective degradability of dry matter compared to CM and WDDGS (61.6 ± 1.0% and 65.6 ± 0.5%) and the lowest rumen degradable dry matter (21.9 ± 3.9 %; $P < 0.05$) compared to CM and WDDGS (38.4 ± 1% and 34.5 ± 0.6%). As with dry matter, WDDGS had the highest S fraction (25.7 ± 0.1%; $P < 0.05$) of crude protein and the lowest D fraction (69.1 ± 0.6%; $P < 0.05$) compared to CM (S: 6.8 ± 1.0%; D: 84.6 ± 1.0%) and SBM (S: 9.3 ± 1.2%; D: 89.1 ± 2.8%) but an intermediate U fraction (5.3 ± 1.5%). Soybean meal had the lowest U fraction (1.6 ± 1.6%; $P < 0.05$) compared to CM (8.6 ± 1.0%), meaning it had the highest effective degradability of protein (61.4 ± 7.4%) compared to CM and WDDGS (56.0 ± 1.9% and 53.1 ± 0.2%), although it was not significant ($P > 0.05$). Numerically ($P > 0.05$), WDDGS had the highest content of RUP (46.9 ± 0.2%), closely followed by CM (44.0 ± 1.9%) with SBM having the least RUP (38.6 ± 7.4%).

Metabolism (Nutrient Utilization) Trial

A metabolism trial was conducted to compare canola meal (**CM)** versus soybean meal (**SBM)** fed with or without wheat dried distiller's grains with solubles (**WDDGS**) as crude protein (**CP**) supplements for beef cattle. The trial evaluated rumen fermentation and ruminal and total tract nutrient digestibility characteristics of 4 cannulated heifers in a Latin square design with a 2 formulated with one of four protein supplements included: 1) CM (8.8% DM), 2) SBM (6.6% DM), 3) CM+WDDGS (6.4 and 3.3% DM), 4) SBM+WDDGS (5.0 and 2.8% DM). Omasal, rumen, and fecal samples were collected every 8 h for 3 d following 10 d of infusion with YbCl, Cr-EDTA, and ^{15}N to determine omasal flow of nutrients and microbial protein production. Heifers fed WDDGS had lower ($P < 0.05$) DM (11.8 ± 0.3 kg d^{-1} vs. 13.3 ± 0.4 kg d^{-1}), OM (11.0 ± 0.3 kg d^{-1} vs. 12.1 ± 0.4 kg d^{-1}), and N intake (246.9 ± 6.6 g d^{-1} vs. 278.9 ± 12.2 g d^{-1}) than those not fed WDDGS. Canola meal tended (1,283.8 ± 67.7 g d^{-1}; $P = 0.08$) to increase RDP supply compared to diets containing SBM (1,042.2 ± 85.7 g d^{-1}). There was a tendency ($P < 0.10$) for heifers fed CM to have lower omasal outflow of DM (9.2 ± 0.6 kg d^{-1} vs. 10.4 ± 0.8 kg d^{-1}) and OM (7.7 ± 0.5 kg d^{-1} vs. 8.8 ± 0.6 kg d^{-1}) compared to those fed SBM. Diets containing CM had the most DM (4.2 ± 0.4 kg d^{-1} vs. 2.8 ± 0.3 kg d^{-1}; $P < 0.05$) and OM (36.9 ± 3.6% vs. 27.1 ± 1.9%) apparently digested in the rumen compared to diets containing SBM and there was a tendency for WDDGS to decrease DM apparently digested in the rumen (2.8 ± 0.3 kg d^{-1} vs. 3.5 ± 0.4 kg d^{-1}; $P < 0.10$). A Meal type by WDDGS interaction ($P < 0.05$) for N apparently digested in the rumen indicates that when WDDGS was added to CM diets, apparent N digestibility decreased (-58.7 ± 12.1 g d^{-1} vs. -81.9 ± 22.5 g d^{-1}), while it improved when fed with SBM (-132.2 ± 13.6 vs. -117.5 ± 19.1 g d^{-1}). Diets containing CM had a higher apparent digestibility of N in the rumen (-58.7 ± 12.1 g d^{-1}; -21.3 ± 5.5% vs. -132.2 ± 13.6 g d^{-1}; -44.3 ± 3.0%; $P = 0.01$) [1]) than diets containing SBM and increased ($P = 0.03$) N truly digested in the rumen (181.1± 11.5 g d^{-1}vs. 138.6 ± 13.6 g d^{-1}). The inclusion of WDDGS in the diet tended ($P = 0.08$) to decrease the N truly digested in the rumen (139.1 ± 8.8 g d^{-1}) compared to diets without WDDGS (159.8 ± 11.5 g d^{-1}). Amino acid flow to the small intestine was not (P>0.05) affected by treatment. There were no treatment differences ($P > 0.05$) noted in apparent total tract digestibility of DM (61.13 ± 0.57%), OM (62.7 ± 0.8%), crude protein (70.1 ± 0.8%), ADF (33.3 ± 2.3%), or NDF (36.1 ± 1.1%). These results indicate CM is equal to SBM as a protein supplement and that there is no benefit to adding WDDGS with respect to rumen fermentation or total tract nutrient digestion.

Significance of the Results:

The purpose of this research was to determine the usefulness of CM as a protein supplement for feedlot cattle compared to SBM. The objectives were to 1) compare the performance of growing beef cattle fed CM as a protein supplement relative to SBM when fed with or without WDDGS, 2) determine the effect of CM relative to SBM or WDDGS on performance and carcass quality of finishing cattle, and 3) determine if CM supplementation either alone or in combination with WDDGS improves rumen fermentation, ruminal nutrient digestion, microbial protein synthesis, intestinal amino acid supply, and total tract nutrient digestion in growing beef cattle compared to SBM. The hypothesis was that CM would prove to be an effective protein supplement compared to SBM and CM's superior RDP to RUP ratio and supply of essential amino acids would improve performance of feedlot cattle and that extra RUP supplied by WDDGS would further improve performance.

Two feedlot trials and an in situ trial were run to determine the effect of CM versus SBM with or without WDDGS as a RUP source on backgrounding and finishing growth performance and carcass quality. The first trial consisted of a 95-d backgrounding program using 398 steer calves (288 ± 17.6 kg) randomly assigned to 12 pens and fed one of four barley based backgrounding diets supplemented with either CM, SBM, CM+WDDGS, or SBM+WDDGS. The second trial consisted of a 61-d backgrounding period followed by a 147-d finishing program using 300 head (305 ± 18.4kg) randomly assigned to 25 pens and fed one of five barley based finishing diets supplemented with either CM, SBM, WDDGS, CM+WDDGS, or SBM+WDDGS. The in situ trial evaluated each of the protein supplements in triplicate in 'gradual in, all out' 48-h ruminal incubations.

As predicted, the effective dry matter degradability of SBM (78.1 ± 3.9%; $P < 0.05$) was higher than that of CM and WDDGS (61.6 ± 1.0% and 65.6 ± 0.5%), the effective degradability of protein followed the same pattern (SBM- 61.4 ± 7.4%; CM- 56.0 ± 1.9%, WDDGS- 53.1 ± 0.2%; $P > 0.05$), although it was not significant. This resulted in RUP values for the three protein supplements being closer in value to each other than was expected (SBM- 38.6 ± 7.4%; CM- 44.0 ± 1.9%, WDDGS- 46.9 ± 0.2%), although all three values were within the range of previously reported values (Li et al. 2013; Maxin et al. 2013b; Paz et al. 2014). It is possible that CM having a higher RUP value than expected is due to the addition of gums, phospholipids, and screenings back into the meal during processing. Canola meal and soybean meal had lower S fractions than expected, which also contributed to RUP being higher than expected in these meals. This is likely due to the fact that the supplements were left as is as opposed to being ground prior to incubation and the bags had a smaller pore size than other trials (Stanford et al. 1996; Li et al. 2012) which decreased the amount of particles able to wash out of the nylon bags.

In the backgrounding trial (Trial 1), the only parameter affected by treatment was ADG with cattle fed SBM+WDDGS having the lowest ($P = 0.03$) ADG (1.32 ± 0.03 kg d^{-1}) compared to those fed SBM (1.45 ± 0.04 kg d^{-1}) with cattle fed CM and CM+WDDGS being intermediate. There were no treatment differences noted in final body weight, DMI, G:F, or feed cost of gain. Although there were no significant differences ($P > 0.05$) seen in feed cost of gain, cattle fed CM ($0.98 kg^{-1}) as opposed to SBM ($1.03 kg^{-1}) had a $0.05 kg^{-1} saving, and the addition of WDDGS to either CM ($0.93 kg^{-1}) or SBM ($0.98 kg^{-1}) saved an additional $0.05 kg^{-1}. Feed costs are the biggest cost to feedlot producers, so a savings of $0.05 or $0.10 per kilogram of gain without negative repercussions on growth is of significant importance to producers, making the combination of CM+WDDGS the most ideal protein supplement in Trial 1.

In Trial 2, cattle fed CM+WDDGS had the highest (8.4 ± 0.1 kg d^{-1}; $P = 0.04$) DMI during backgrounding compared to cattle fed SBM (7.9 ± 0.1 kg d^{-1}), although this effect on DMI did not carry through to the finishing portion of the trial. No treatment effects were seen on backgrounding, finishing, or overall ADG or G:F. Once again, no significant effect was seen in feed cost of gain ($P > 0.05$), but cattle fed SBM had the numerically highest cost of gain ($1.31 kg^{-1}) with cattle fed CM having a saving of $0.05 per kilogram of gain ($1.26 kg^{-1}) and cattle fed WDDGS having an even lower feed cost of gain ($1.22 kg^{-1}). The addition of WDDGS to SBM resulted in a saving of 3 cents per kilogram ($1.28 kg^{-1}) while the addition of WDDGS to CM did not change the feed cost of gain ($1.26 kg^{-1}). No treatment effects ($P > 0.05$) were seen in hot carcass weight, *Longissimus Dorsi* area, or dressing percentage. Cattle fed SBM+WDDGS had the least fat deposition of the treatments, with lower fat depth (1.17 ± 0.06 cm; $P > 0.05$) compared to CM+WDDGS (1.46 ± 0.05 cm), lower marbling score (398.75 ± 15.19) compared

to WDDGS (440.10 ± 8.20), and a tendency to have fewer AAA carcasses (41.4 ± 6.5%; $P < 0.10$) than cattle fed WDDGS (41.4 ± 6.5%).

Some changes were seen in carcass fatty acid composition between treatments and from pre-feeding to finish. As expected, the production of MUFA decreased between pre-feeding and finish as did CLA, CLnA, and BCFA. While these data could not be statistically analyzed due to the difference in fat depot sampled, the changes in fatty acid concentration were expected as similar differences have been noted in grass fed versus grain fed cattle. Cattle fed WDDGS in combination with CM and SBM had better fatty acid profiles, with higher concentrations of C18:3 n-3 (0.24 ± 0.01% FAME vs. 0.21 ± 0.01% FAME), *t*11-18:1 (0.45 ± 0.02% FAME vs. 0.29 ± 0.02% FAME), and *c*7-16:1 (0.17 ± 0.01% FAME vs. 0.14 ± 0.01% FAME) and lower concentrations of *t*10-18:1 (1.03 ± 0.14% FAME vs. 1.32 ± 0.19% FAME) and C17:0 (1.03 ± 0.04% FAME vs. 1.15 ± 0.02% FAME) compared to those fed just CM or SBM. Omega-3 fatty acids and several MUFA, including *t*11-18:1, and *c*7-16:1, have been found to be beneficial to human health while some MUFA, including *t*10-18:1, and SFA have been found to have negative effects on human health. The shift in the fatty acid concentration is consistent with differences between cattle fed high concentrate diets and cattle fed high forage diets, suggesting that inclusion of WDDGS can reverse some of the negative effects of high concentrate feeding to a small extent and that the combination of WDDGS with an oilseed meal may further benefit this shift.

It was expected that CM would improve performance of cattle in the feedlot due to its previously reported ideal supply of essential amino acids and RDP/RUP ratio and its widespread use in the dairy industry (Mutsvangwa 2017). One of the causes for the similarity between treatments could have been the narrow range of RUP values of the three protein supplements. According to values from the Canadian International Grain Institute (2013) and the Canola Council of Canada (2015), the predicted RUP range of the protein supplements used in this trial would've been 33.3% to 54.5%. Instead, the range of RUP of the protein supplements determined by the in situ trial was 38.6% to 46.9%, making the opportunity to see any effects of RUP on performance much smaller. Another reason the protein supplements had lower than expected effects in the feedlot trials, could have been the relatively low inclusion rate of protein supplements in the diets compared to lactating dairy cow diets. Lactating dairy cows have a higher requirement for protein than growing and finishing beef steers and therefore have a higher inclusion rate of protein supplements in their diets. Previous work comparing CM to other protein supplements, including SBM and WDDGS, have inclusion rates of CM from 8.8% of dietary DM to 20.8% of the diet (Chibisa et al. 2012; Maxin et al. 2013a). In Trial 1, CM was included at 8.7% of the diet, and in Trial 2, the finishing diet included CM at 5.7%. The lower inclusion level of protein supplements in feedlot diets, coupled with the narrow range of RUP values in the protein supplements, would have made it much more difficult to see any effects of protein supplements.

A metabolism trial was conducted to determine the effects of CM versus SBM with or without WDDGS on rumen fermentation, apparent rumen digestibility, microbial protein production, and total tract digestibility in backgrounding beef heifers. Heifers were fed barley based backgrounding diets supplemented with one of four protein treatments: 1) CM (8.8% DM), 2) SBM (6.6% DM), 3) CM+WDDGS (6.4 and 3.3% DM), 4) SBM+WDDGS (5.0 and 2.8% DM) in a Latin square design balanced for carry over effects. Rumen samples, omasal samples, and fecal samples were taken to determine rumen fermentation characteristics and nutrient

digestibility. The triple marker method (using Cr, Yb, and iNDF) was used with the omasal sampling technique to estimate omasal nutrient outflow.

Overall rumen fermentation was not affected by protein source, which was to be expected given the similarity in degradability of the protein sources seen in the in situ trial. Contrary to the feedlot trials, heifers fed diets including WDDGS had lower DMI (11.8 ± 0.3 kg d^{-1}; $P < 0.05$) and organic matter intake (11.0 ± 0.3 kg d^{-1}) than heifers fed diets not containing WDDGS (13.3 ± 0.4 kg d^{-1} and 12.1 ± 0.4 kg d^{-1}). One of the reasons for this conflicting result is that the heifers in the metabolism trial had a much higher start of trial weight (540.3 ± 28.6 kg BW) than the steers in the feedlot trials (1- 288 ± 17.6 kg; 2- 305 ± 18.4kg).

Diets containing CM were more digestible in the rumen than diets containing SBM. The CM diet ($P < 0.05$) had a higher apparent ruminal DM digestibility (31.7 ± 2.9% vs. 21.2 ± 2.6%) and organic matter apparently digested in the rumen (36.9 ± 3.6% vs. 27.1 ± 1.9%). No treatment differences were seen in NDF or ADF digestibility in the rumen. The ADF digestibility however, was higher than expected based on the NDF digestibility and ADF total tract digestibility. This is mathematically impossible, so the ADF apparent ruminal digestibility value was removed from the results table.

Overall, the apparent ruminal digestibility of nutrients were lower than expected based on similar work with beef cattle (Li et al. 2013; Owens et al. 2014; Gorka et al. 2015). This may have been the result of dysfunction with marker recovery. It has been noted that using the triple marker method with the omasal sampling technique does not always work as expected for animals fed high concentrate diets (Titgemeyer 1997). The smaller particle size of oat hulls used in the current trial may have sped up the passage rate of the diet so that it became closer to the passage rate of a higher concentrate diet rather than the 55% forage diet that it was, leading to errors in marker recovery and underestimation of apparent rumuinal digestibility.

Somewhat surprisingly, the CM diet supplied more RDP than the SBM diet (9.6 ± 0.3% DMI vs 7.8 ± 0.3% DMI; $P < 0.05$). Diets containing CM also had an increased ($P < 0.05$) apparent digestibility of nitrogen in the rumen (-24.9 ± 5.5% vs. -49.8 ± 3.0%) and decreased NAN flow out of the rumen compared to SBM (106.1 ± 5.4% vs. 140.1 ± 3.6%). This was unexpected based on the results from the in situ trial and literature RUP values. Based on these, it would have been expected that diets containing CM would have had a lower apparent N digestibility in the rumen and an increased NAN flow. No differences were seen in total flow of bacterial NAN, nor were there any differences seen in microbial efficiency. Diets that are higher in RUP should have a lower microbial NAN flow due to the reduced degradable protein available for microbial synthesis and the increased dependence on recycled nitrogen (Wagner et al. 2010). Based on this, the CM diets which supplied more RDP than diets containing SBM would have been expected to have a higher bacterial NAN flow than the SBM diets.

No differences were seen in total tract nutrient digestibility between diets containing CM or SBM, suggesting that the type of protein supplement used had no effect on total tract digestibility.

Based on this research, it can be concluded that CM is equal to SBM as a protein supplement for feedlot cattle. No differences in performance were noted between growing and finishing steers fed CM versus SBM, and only minor differences were seen in apparent ruminal and total tract nutrient digestibility. Slight improvements were seen in the feed cost of gain when CM was fed compared to SBM and when WDDGS was added to either supplement, suggesting SBM may be of the least economic benefit to livestock producers.

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