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# Effect of Energy Source and Escape Protein on Receiving and Finishing Performance and Health of Calves

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**Summary**

*One receiving trial and one finishing trial evaluated the effect of energy source and protein supplement on performance and health of large-frame calves. In the receiving trial, diets were comprised (DM basis) of 45% alfalfa hay, and either 55% dry rolled corn, molasses, and supplement or 55% wet corn gluten feed and supplement. Diets contained a supplement without or with escape protein. Calves fed wet corn gluten feed consumed less dry matter, had a lower metabolizable protein supply, were more efficient, but gained similarly to calves fed dry rolled corn. Calves supplemented with escape protein had a greater metabolizable protein supply than calves not supplemented with escape protein. Health was not affected by dietary treatment. In the finishing trial, energy sources included dry rolled corn, dry rolled corn/wet corn gluten feed, high moisture corn, high moisture corn/wet corn gluten feed, and dry rolled corn/high moisture corn. Diets contained a supplement without or with escape protein. An energy source × protein supplement interaction was observed for daily gain and feed/gain. Results suggest wet corn gluten feed, fed in combination with dry rolled corn or high moisture corn, has an energy value similar to those grains fed individually.*

## Introduction

Large-frame calves are well suited to a production system in which finishing begins shortly after weaning.

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Compared with yearlings, calves are less mature and deposit more lean tissue relative to fat when placed in the feedlot. Therefore, the need for metabolizable protein is greater with calves.

Wet corn gluten feed (WCGF) has been shown to be an excellent energy source in beef cattle diets. Compared with dry rolled corn (DRC), WCGF is higher in crude protein, but the escape protein value of WCGF is substantially lower (60 vs 20%). Previous research (1995 Nebraska Beef Report, pp. 28-30) showed supplemental escape protein improved efficiency of calves fed DRC/alfalfa and WCGF/alfalfa receiving diets. Most of this response was due to escape protein improving efficiency of calves fed WCGF. Calves fed DRC- or DRC/WCGF-based finishing diets performed similarly, regardless of escape protein supplementation, but metabolizable protein supply was near or exceeded the animal's requirement in all dietary treatments.

High moisture corn (HMC) is used widely in beef cattle diets. The crude protein content of HMC and DRC is similar, however, the escape protein value of HMC is lower than that of DRC (40 vs 60%). The lower escape protein potential of WCGF and HMC may create a deficiency in metabolizable protein and enhance the need for escape protein supplementation when these two feeds are fed together.

The objective of this research was to determine the effect of feeding WCGF and escape protein on performance and health of calves during the receiving period and subsequent finishing period. This report represents the second year of research with this objective. Additionally, HMC, HMC/WCGF, and DRC/HMC were included as energy sources in the second year's finishing trial to evaluate the need for supplemental escape protein in these diets.

## Procedure

*Receiving Trial*

Three hundred fifteen large-frame steer calves (556 lb) from three groups were used in the receiving trial. Calves were delivered directly from ranches or sale barns and were representative of those typically available to Nebraska cattle feeders. Calves were received at the Nebraska Agricultural Research and Development Center, Mead, during the fall of 1994. Groups one and three had access to grass hay and water for approximately one hour before weighing and processing. Group two was weighed and processed shortly after arrival and did not have access to feed or water. Within each group, calves were assigned randomly to treatments.

Diets were comprised (DM basis) of 45% alfalfa hay, 45% DRC, 6% molasses, and 4% supplement or 45% alfalfa hay, 52% WCGF (Minnesota Corn Processors), and 3% supplement. Based on results from Year 1, 19.5% DRC was included in WCGF diets for the initial 7 days of feeding to increase feed intake during the first week. Each diet was fed without or with supplemental escape protein [80% feather meal:20% blood meal combination (CP basis)]. Dietary crude protein levels were 15.1% for DRC/urea, 16.3% for DRC/escape protein, 17.3% for WCGF, and 19.1% for WCGF/escape protein. Diets were formulated to meet the rumen degradable protein requirement based on Burrough's equation for growing diets (TDN x .13), which would meet or exceed the nitrogen needs of ruminal microbes. Additionally, diets were formulated to contain a minimum of .5% Ca, .35% P, and 1.3% K. Diets containing WCGF were also formulated to supply a minimum of 50 mg thiamine/head/day.

Calves were observed daily for sickness. Sick calves were moved from their pen to respective hospital pens, maintained on their dietary treatment, and treated with antibiotics until health was restored.

The receiving trial lasted 20 to 32 days; group one was fed 32 days, group two was fed 28 days and group three was fed 20 days. Final weights were determined as the average weights of two consecutive days at completion of the receiving period. Final weights were shrunk 2% for groups one and three and 4% for group two to minimize differences with incoming shrink.

*Finishing Trial*

Three hundred twenty calves (658 lb) were used in the finishing trial. Steers were blocked by weight and assigned randomly, within block, to one of ten pens (8 head/pen). Five concentrate energy sources were evaluated (Table 1): DRC; DRC/WCGF; HMC; HMC/WCGF; and DRC/HMC. Each diet was fed without or with supplemental escape protein. Steers were adapted to final finishing diets using four adaptation diets containing (DM basis) 45 (2 days), 35 (6 days), 25 (7 days), and 15% (7 days) roughage.

Diets were formulated for a minimum of 12% crude protein. Actual crude protein values of DRC, HMC, and corn silage were lower than expected, resulting in reduced dietary crude protein levels (Table 1). An 80% feather meal:20% blood meal combination (CP basis) was used as the escape protein supplement. Diets were formulated to meet the rumen degradable protein requirement (TDN x .081), based on the Cornell Net Carbohydrate and Protein system (Ainslie et al., J. Anim. Sci., 1993). Additionally, diets were formulated to contain a minimum of .7% Ca, .35% P, .7% K, 25 g Rumensin/ton and 10 g Tylan/ton. Diets containing WCGF were also formulated to supply a minimum of 50 mg thiamine/head/day. Steers were implanted with Revalor at the start of the finishing trial and at 83 days. Steers were finished for an average of 164 days and final weights were determined by using hot carcass weight, assuming a 62% dressing percentage. Fat thickness at the 12th rib, USDA yield and quality grades, and liver score were recorded.

## Results

*Receiving Trial*

Calves fed WCGF consumed less DM ($P<.01$), had a lower metabolizable protein supply ($P<.01$), gained similarly, but were more efficient ($P<.10$) than calves fed DRC (Table 2) . Results from Year 1 (1995 Nebraska Beef Report, pp. 28-30) also showed lower DM intake and metabolizable protein

**Table 1. Finishing diet composition (% DM basis)**

| Ingredient | Energy source and escape protein[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | DRC | DRC/ WCGF | HMC | HMC/ WCGF | DRC/ HMC | DRC/ EP | DRC/ WCGF/ EP | HMC/ EP | HMC/ WCGF/ EP | DRC/ HMC/ EP |
| Dry rolled corn | 78.91 | 42.00 | — | — | 36.91 | 77.91 | 40.00 | — | — | 37.91 |
| Wet corn gluten feed | — | 45.00 | — | 45.00 | — | — | 45.00 | — | 45.00 | — |
| High moisture corn | — | — | 78.91 | 42.00 | 42.00 | — | — | 77.91 | 40.00 | 40.00 |
| Molasses | 6.09 | — | 6.09 | — | 6.09 | 6.09 | — | 6.09 | — | 6.09 |
| Alfalfa hay | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Corn silage | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Urea | 1.17 | — | 1.17 | — | 1.17 | 1.17 | — | 1.17 | — | 1.17 |
| Feather meal | — | — | — | — | — | 1.76 | 1.76 | 1.76 | 1.76 | 1.76 |
| Blood meal | — | — | — | — | — | .45 | .45 | .45 | .45 | .45 |
| Supplement[b] | 3.83 | 3.00 | 3.83 | 3.00 | 3.83 | 2.62 | 2.79 | 2.62 | 2.79 | 2.62 |
| Crude protein[c] | 10.4 | 10.7 | 10.8 | 11.0 | 10.6 | 12.2 | 12.6 | 12.7 | 12.8 | 12.4 |
| Degradable intake protein[d] | 6.7 | 7.3 | 8.1 | 8.1 | 7.4 | 7.4 | 8.0 | 8.8 | 8.7 | 8.1 |

[a]DRC = dry rolled corn; WCGF = wet corn gluten feed; HMC = high moisture corn; EP = supplemental escape protein.
[b]Includes vitamins, minerals, and feed additives.
[c]Based on analysis of individual ingredients.
[d]Degradable intake protein requirement calculated as TDN × .081 = 6.8%.

supply with calves fed WCGF (P<.01). However, calves fed WCGF in Year 1 gained less (P<.05) than calves fed DRC and were more efficient only when supplemented with escape protein. In one group, one to two weeks passed before DM intake of calves fed WCGF diets approached that of calves fed DRC diets. However, no intake reduction was observed in the other two groups. Some calves may initially have a slight aversion to diets containing 32.5% WCGF.

Calves supplemented with escape protein had a higher metabolizable protein supply (P<.05) than calves not supplemented with escape protein, but daily gain and feed efficiency were not different. In Year 1, calves supplemented with escape protein also had a higher metabolizable protein supply (P<.01); however, supplemental escape protein improved feed efficiency (P<.10) in Year 1.

When data were pooled across years, a year × energy source interaction (P<.10) was observed for daily gain, DM intake, and feed/gain. In Year 1, calves gained faster when fed DRC than WCGF, but efficiency was similar. In Year 2, gains were similar but feed efficiency was greater with WCGF. Additionally, a year × protein supplement interaction was observed for daily gain (P<.10). Escape protein numerically (P>.10) increased gain in Year 1, but numerically (P>.10) decreased gain in Year 2. Performance during the receiving period can be highly variable. The number of cattle treated for respiratory disease was greater in Year 1 than Year 2. The reduced sickness may explain the higher dry matter intakes and daily gains observed with all cattle in Year 2 and the lack of improvement in daily gain and feed efficiency with escape protein supplementation. The number of calves requiring treatment for respiratory disease [27 (15.0%), 22 (12.4%), 31 (17.4%), and 29 (16.4%) for DRC/urea, DRC/escape protein, WCGF, and WCGF/escape protein, respectively] was not different (P>.15). However, a negative correlation existed between metabolizable protein supply and number of calves treated for respiratory disease (r=-.66; P<.01) indicating that in-creased metabolizable protein supply may have reduced sickness in these calves.

**Table 2. Effect of energy and protein source on receiving performance and health**

| Item | Treatment[a] | | | |
|---|---|---|---|---|
| | DRC/Urea | DRC/EP | WCGF | WCGF/EP |
| Total head/treatment | 79 | 78 | 79 | 79 |
| DM intake[b], lb/day | 14.99 | 14.71 | 12.98 | 12.48 |
| Daily gain, lb | 2.39 | 2.20 | 2.47 | 2.21 |
| Feed/gain[cd] | 6.61 | 7.00 | 5.30 | 5.68 |
| Number of dead cattle | 0 | 0 | 1 | 0 |
| Number of treated cattle[e] | 7 | 5 | 6 | 8 |
| MP supply[bfg], lb/day | 1.31 | 1.44 | 1.13 | 1.21 |
| Degradable intake protein[h], % | 10.6 | 10.6 | 12.6 | 13.1 |

[a]Performance does not include dead cattle. DRC = dry rolled corn; EP = escape protein; WCGF = wet corn gluten feed.
[b]DRC vs WCGF (P<.01).
[c]DRC vs WCGF (P<.10).
[d]Feed/gain analyzed as gain/feed. Feed/gain is reciprocal of gain/feed.
[e]Treated with antibiotic injection to control respiratory disease.
[f]No escape protein supplement vs escape protein supplement (P<.05).
[g]Metabolizable protein (MP) requirement of a 588 lb steer (average trial weight) gaining 2.47 lb/day (maximum trial gain) = 1.21 lb/day (Ainslie et al., J. Anim. Sci., 1993).
[h]Degradable intake protein requirement calculated as TDN × .13 = 9.4%.

*Finishing Trial*

An energy source × protein supplement interaction was observed for daily gain (P<.10) and feed/gain (P<.01) (Table 3). The biological

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**Table 3. Effect of energy source[a] and protein supplement on finishing gain and efficiency.**

| | Without escape protein | | | | | With escape protein | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Item | DRC | DRC/ WCGF | HMC | HMC/ WCGF | DRC/ HMC | DRC | DRC/ WCGF | HMC | HMC/ WCGF | DRC/ HMC |
| Daily gain[b], lb | 3.55 | 3.65 | 3.54 | 3.49 | 3.60 | 3.74[c] | 3.51[d] | 3.75[c] | 3.47[d] | 3.60[cd] |
| Feed/gain[f] | 6.61[c] | 6.26[d] | 6.44[cd] | 6.18[d] | 5.91[e] | 6.08[cd] | 6.27[c] | 5.96[d] | 6.25[c] | 6.14[cd] |

[a]DRC = dry rolled corn; WCGF = wet corn gluten feed; HMC = high moisture corn; EP = supplemental escape protein.
[b]Energy source × protein supplement interaction (P <.10).
[cde]Means within a protein supplement and within a row having unlike superscripts differ (P<.10).
[f]Energy source × protein supplement interaction (P <.01).

**Table 4. Effect of energy source on finishing dry matter intake, metabolizable protein supply, and carcass characteristics.**

| | Energy source[a] | | | | |
|---|---|---|---|---|---|
| Item | DRC | DRC/ WCGF | HMC | HMC/ WCGF | DRC/ HMC |
| DM intake, lb/day | 23.18[b] | 22.40[c] | 22.56[bc] | 21.63[d] | 21.67[d] |
| MP supply[e], lb/day | 1.82[b] | 1.73[c] | 1.61[d] | 1.59[d] | 1.62[d] |
| Quality grade[f] | 19.0[b] | 18.7[c] | 18.7[c] | 18.5[c] | 18.6[c] |
| Yield grade | 2.69[b] | 2.48[c] | 2.59[bc] | 2.58[bc] | 2.65[bc] |
| Fat thickness | .51[b] | .45[c] | .48[bc] | .46[c] | .49[bc] |

[a]DRC = dry rolled corn; WCGF = wet corn gluten feed; HMC = high moisture corn.
[bcd]Means within a row with unlike superscripts differ (P<.10).
[e]Metabolizable protein (MP) requirement of a 952 lb steer (average trial weight) gaining 3.75 lb/day (maximum trial gain) = 1.75 lb/day (Ainslie et al., J. Anim. Sci., 1993).
[f]19.0 = low choice.

explanations for these interactions are unclear. Escape protein supplementation improved the performance of calves fed DRC, which supplied the greatest amount of metabolizable protein, but did not improve the performance of calves fed diets containing WCGF, which supplied lower levels of metabolizable protein. Most likely, the significant interactions are associated with random variation associated with 10 treatments and only four replications. Within treatments not supplemented with escape protein, calves fed DRC/HMC were the most efficient (P<.10). Additionally, calves fed DRC/WCGF or HMC/WCGF were more efficient than calves fed DRC (P<.10) with calves fed HMC being intermediate. Energy source had no effect on daily gain for these treatments.

Within treatments supplemented with escape protein, calves fed DRC or HMC gained faster (P<.10) than calves fed DRC/WCGF or HMC/WCGF with calves fed DRC/HMC being intermediate. Calves fed HMC were more efficient than calves fed DRC/WCGF or HMC/WCGF (P<.10) with calves fed DRC or DRC/HMC being intermediate.

Calves fed HMC/WCGF and DRC/HMC consumed less DM (P<.10) than calves fed DRC, DRC/WCGF, or HMC (Table 4). Calves fed DRC/WCGF consumed less DM (P<.10) than calves fed DRC which agrees with results from Year 1 (1995 Nebraska Beef Report, pp. 28-30). Metabolizable protein supply was lower (P<.10) for calves fed HMC, HMC/WCGF, or DRC/HMC compared to calves fed DRC or DRC/WCGF. Calves fed DRC/WCGF had a lower metabolizable protein supply than calves fed DRC (P<.10), as in Year 1. Quality grade was higher (P<.10) for calves fed DRC although differences were small. Yield grade and fat thickness were lower (P<.10) for calves fed DRC/WCGF compared to calves fed DRC, but again, differences were small. Liver score was not affected (P>.10) by dietary treatment (data not shown). Metabolizable protein supply of calves fed supplemental escape protein was higher (P<.01) than calves not fed supplemental escape protein (data not shown).

In Year 1 and 2, performance of calves fed DRC and DRC/WCGF was evaluated. A year × energy source × protein supplement interaction was observed for daily gain (P<.05) and feed/gain (P<.10). Escape protein improved daily gain and feed efficiency of calves fed DRC in Year 2, but did not affect performance of calves fed either DRC or DRC/WCGF in Year 1, or DRC/WCGF in Year 2.

The amount of supplemental escape protein required to meet the metabolizable protein needs of finishing cattle is small. It is likely that calves fed finishing diets containing DRC or DRC and 45% WCGF are deficient in metabolizable protein during early finishing (0 to 90 days) when rapid muscle growth occurs, but the need for supplemental escape protein declines as cattle fatten.

Results of this research suggest wet corn gluten feed, fed in combination with dry rolled corn or high moisture corn, has an energy value similar to those grains fed individually. Receiving diets containing wet corn gluten feed and finishing diets containing wet corn gluten feed or high moisture corn may supply metabolizable protein near the requirement. However, metabolizable protein supply is also dependent on other dietary components and intake. Therefore, escape protein supplementation may be necessary to ensure maximum performance.

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