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# Crude Protein and Wet Corn Gluten Feed Levels for Steam Flaked Corn Finishing Diets

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# Crude Protein and Wet Corn Gluten Feed Levels for Steam Flaked Corn Finishing Diets

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Wet corn gluten feed at 20% to 30 % of diet DM optimized performance and increasing CP levels from 13.4% to 15.0% improved performance linearly for steers fed steam-flaked corn.

**Summary**

*Data from three trials suggest steam-flaked corn finishing diets for yearling steers containing corn bran benefit from inclusion of steep liquor at 10% of diet DM, and indicate steam-flaked corn finishing diets for steer calves containing 20% to 30% wet corn gluten feed resulted in optimal performance. With 20% to 30% wet corn gluten feed, calves responded to CP above 13.4% and the requirement for CP is as high as 15.0%*

**Introduction**

Corn steep liquor (± distiller solubles) and corn bran (± solvent extracted germ meal) are the primary components of wet corn gluten feed. Steep liquor has a higher energy value than dry rolled corn or corn bran, and complements corn bran in wet corn gluten feed. Wet corn gluten feed alleviates acidosis in dry-rolled corn finishing diets, improving performance. Both steep liquor and wet corn gluten feed supply degradable intake protein (DIP) as true protein and

**Table 1. Diet composition for Trial 1, 2, and 3 (% DM basis).**

| Treatment | Trial 1 | | | Trial 2 | | Trial 3 | | | |
|---|---|---|---|---|---|---|---|---|---|
| Steep liquor: | 0% | 10% | 20% | 0% | 10% | — | — | — | — |
| Wet corn gluten feed: | — | — | — | — | — | 0% | 20% | 30% | 40% |
| Ingredient | | | | | | | | | |
| Steam-flaked corn | 65 | 55 | 45 | 62.5 | 52.5 | 85 | 65 | 55 | 45 |
| Corn bran | 20 | 20 | 20 | 20 | 20 | — | — | — | — |
| Steep | 0 | 10 | 20 | 0 | 10 | — | — | — | — |
| Wet corn gluten feed | — | — | — | — | — | 0 | 20 | 30 | 40 |
| Corn silage | — | — | — | — | — | 10 | 10 | 10 | 10 |
| Alfalfa hay | 7 | 7 | 7 | 4 | 4 | — | — | — | — |
| Cottonseed hulls | — | — | — | 3.5 | 3.5 | — | — | — | — |
| Molasses | 3 | 3 | 3 | 3 | 3 | — | — | — | — |
| Supplement[a] | 5 | 5 | 5 | 7 | 7 | 5 | 5 | 5 | 5 |

[a]Includes urea, minerals, vitamins, and additives.

may improve performance compared to urea. Greater requirement for DIP has been demonstrated when feeding steam-flaked compared to dry-rolled corn (*2001 Nebraska Beef Report,* pp. 54-56).

The objectives of this research were to determine the optimum level of steep to include into yearling steer finishing diets based on steam-flaked corn and corn bran, and to determine the optimum level of wet corn gluten feed and CP to include in steam-flaked corn finishing diets for steer calves.

## Procedure

### *Trial 1*

Ninety-three yearling steers (863 ± 66 lb) were used in a finishing trial from Sept. 27, 2000 to Jan. 9, 2001 (104 d) to investigate effects of level of steep liquor inclusion in steam-flaked corn and corn bran based diets. The steep used in this trial was a combination of steep liquor and distillers solubles. Treatments for this trial consisted of adding steep at 0%, 10%, and 20% of diet DM. Twelve pens of steers, seven or eight steers per pen, were randomly allotted to the three treatments, resulting in four replicates per treatment.

Diets for this trial (Table 1) were formulated to contain (DM basis) a minimum of 13.0% CP, 0.70% Ca, 0.35% P, and 0.70% K, and included 27 g/ton monensin and 10 g/ton tylosin. Steers were adapted to the final diet by using four adaptation diets containing alfalfa hay at 45%, 35%, 25%, and 15% of DM for three, four, seven and seven days, respectively. Steers were implanted with Revalor-S and treated for internal and external parasites with Cydectin on day 1. Initial weights were an average of two consecutive weights taken before feeding. Final weights were calculated using hot carcass weight divided by a common dressing percentage (62.8). Hot carcass weights and liver abscess scores were recorded at slaughter. Fat thickness at the 12th rib, ribeye area, quality grade, and yield grade were recorded after a 24-hour chill. Data were analyzed for linear and quadratic effects of steep level using the mixed models procedure of SAS.

### *Trial 2*

Eighteen individually fed yearling steers (765 ± 66 lb) were used in an individual feeding trial from April 19, 2000 to Aug. 16, 2000 (154 d) to investigate the effect of inclusion of steep in steam-flaked corn and corn bran based diets. The steep used in this trial was a combination of steep liquor and distiller solubles. Treatments consisted of adding steep at 0% or 10% of diet DM. Nine steers were individually fed and randomly allotted to each of the treatments.

Diets for this trial (Table 1) were formulated to contain a minimum of 13.4% CP, 0.70% Ca, 0.35% P, and 0.70% K, and included 28 g/ton monensin and 10 g/ton tylosin. Steer intakes were started at 11 lb DM/day and increased by 0.5 lb DM/day to ad libitum intake. Steers were implanted with Synovex-C on day 1 and re-implanted with Component-TES on day 41. Initial weights were an average of three consecutive weights taken before feeding. Final weights were a single weight taken before feeding and shrunk 4%. Data were analyzed for treatment effects using the mixed models procedure of SAS.

### *Trial 3*

Three-hundred sixty steer calves (634 ± 24 lb) were used in a finishing trial from Nov. 8, 2000 to April 23, 2001 (166 d) to investigate the effects of level of wet corn gluten feed (Sweet Bran®)and level of CP in steam-flaked corn based diets. Treatments for this trial consisted of adding wet corn gluten feed at 0%, 20%, 30% and 40% and CP level at 13.0%, 13.7%, and 14.4% of diet DM. The CP levels were achieved by supplementation with urea. The combination of 40% wet corn gluten feed and 13.0% CP was infeasible due to the CP content of the feed ingredients. Previous research (*2001 Nebraska Beef Report,* pp. 54-56) has indicated the DIP requirement of steers fed steam flaked corn finishing diets were met by DIP levels of 7.1% or 9.5% of diet DM, CP levels 11.9% or 14.3% of diet DM, respectively, which corresponded to CP levels ≤ 13.7% of diet DM for this trial. This, in combination with pen availability, resulted in exclusion of the 0% wet corn gluten feed with 13.0% or 14.4% CP treatments. Variation in CP content of feed ingredients resulted in higher than anticipated CP levels. Resulting final CP levels were 13.9% for 0% wet corn gluten feed; 13.4%, 14.1%, and 14.8% for 20% wet corn gluten feed; 13.5%, 14.2%, and 14.9% for 30% wet corn gluten feed; and 14.5% and 15.0% for the 40% wet corn gluten feed treatments. Thirty-six pens of steers, 10 steers per pen, were randomly allotted to the nine treatments, resulting in four replicates per treatment.

Diets for this trial (Table 1) were formulated to contain (DM basis) a minimum of 0.70% Ca, 0.35% P, and 0.70% K, and included 27 g/ton monensin and 10 g/ton tylosin. Steers were adapted to the final diet by using five adaptation diets containing corn silage at 70% (30% and 40% wet corn gluten feed treatments

(Continued on next page)

had corn silage at 65% and 55% of diet DM respectively) for three days, followed by alfalfa hay at 45%, 35%, 25%, and 15% of DM for three, four, eight and seven days, respectively. Steers were vaccinated for respiratory disease (Pyramid), treated for internal and external parasites (Cydectin), and implanted with Synovex-S on d 1. On day 70, steers were retreated for external parasites (Saber) and implanted with Revalor-S. Initial weights were an average of two consecutive weights taken before feeding. Final weights were calculated using hot carcass weight divided by a common dressing percentage (64.58). Hot carcass weights and liver abscess scores were recorded at slaughter. Fat thickness at the 12th rib, ribeye area, quality grade, and yield grade were recorded after a 24-hour chill. Data were analyzed for linear and quadratic effects of wet corn gluten feed level, linear and quadratic effects of CP, linear interaction of wet corn gluten feed and CP, and lack of fit interactions (indicating interaction more complex than linear wet corn gluten feed and CP) using the mixed models procedure of SAS.

**Table 2. Effect of steep liquor on feedlot performance and carcass evaluation.**

| Steep liquor: | 0% | 10% | 20% | SE | Linear [a] | Quadratic[a] |
|---|---|---|---|---|---|---|
| Initial weight, lb | 864 | 864 | 861 | 2.9 | 0.45 | 0.82 |
| ADG, lb | 3.67 | 4.00 | 3.97 | 0.13 | 0.14 | 0.28 |
| DMI, lb/day | 26.3 | 27.2 | 27.8 | 0.6 | 0.12 | 0.83 |
| Feed:gain | 7.22 | 6.83 | 7.01 | 0.15 | 0.34 | 0.16 |
| Hot carcass weight, lb | 781 | 804 | 800 | 10 | 0.20 | 0.29 |
| Fat thickness, in | 0.50 | 0.53 | 0.46 | 0.03 | 0.38 | 0.15 |
| Marbling[b] | 526 | 543 | 532 | 10 | 0.62 | 0.27 |
| Ribeye area, in $^2$ | 12.8 | 12.8 | 13.2 | 0.2 | 0.20 | 0.25 |
| Yield grade | 2.48 | 2.39 | 2.30 | 0.14 | 0.40 | 0.99 |
| Choice, %[c] | 82.8 | 77.4 | 74.2 | — | — | — |

[a]P-value.
[b]Marbling score: 500 = small (low choice), 600 = modest (average choice).
[c]Not analyzed for effect of steep level.

**Table 3. Effect of steep liquor on feedlot performance.**

| Steep liquor: | 0% | 10% | SE | P-value |
|---|---|---|---|---|
| Initial weight, lb | 758 | 773 | 22 | 0.66 |
| Final weight, lb | 1219 | 1226 | 33 | 0.87 |
| ADG, lb | 3.01 | 2.97 | 0.15 | 0.83 |
| DMI, lb/day | 21.8 | 20.9 | 0.55 | 0.26 |
| Feed:gain | 7.30 | 7.11 | 0.21 | 0.53 |

## Results

*Trial 1*

The inclusion of steep at 0%, 10%, or 20% of diet DM did not affect (P > 0.05) the feedlot performance or carcass evaluation variables measured (Table 2). However, observed numerical differences suggest hot carcass weight, ADG, and feed efficiency tended towards quadratic patterns in response to increased levels of steep inclusion. There was a numerical benefit in hot carcass weight (+3%), ADG (+ 9%), and feed efficiency (+5%) to increasing the inclusion of steep from 0% to 10% of DM. Increasing steep from 10% to 20% of DM, resulted in reduced ADG (-1%), no benefit for hot carcass weight (0%) , and decreased feed efficiency (-3%).

*Trial 2*

The inclusion of steep at 10% of diet DM did not affect (P > 0.05) the feedlot performance parameters (Table 3). Observed numerical values for feed efficiency tended to be improved with inclusion of steep at 10% of diet DM. This trend is in the same direction as the numerical differences observed in Trial 1. Numerical differences for DMI in this trial were the reverse of those observed in Trial 1, suggesting this trend will not be revealed as significant in similar trials with more statistical power. The results of these two trials suggest inclusion of steep at 10% of diet DM in steam flaked corn and corn bran based finishing diets may be beneficial in improving feed efficiency.

*Trial 3*

Hot carcass weight, ADG, and feed efficiency (Table 4) responded to increasing levels of wet corn gluten feed in a quadratic fashion (P < 0.05). A linear response to wet corn gluten feed level existed for DMI (P < 0.05). Independent of CP level, ADG is predicted to be 3.42, 3.66, 3.64, and 3.52 lb while feed:gain is predicted to be 5.78, 5.64, 5.72, and 5.90 for wet corn gluten feed levels of 0%, 20%, 30%, and 40% of diet DM, respectively. Hot carcass weight, ADG, and feed efficiency responded to increasing levels of CP in a linear fashion (P < 0.05). Independent of wet corn gluten feed level, ADG is predicted to be 3.51 lb at 13.4% CP, and to increase by 0.11 lb for each addition 1% CP, up to 15.0%, while feed:gain is predicted to be 5.78% at 13.4% CP, and to decrease by 0.04 for each addition 1% CP, up to 15.0%.

Net energy levels for Trial 3 (Table 5) were calculated from feed energy values. Whereas the 20% and 30% wet corn gluten feed levels were optimal, and a formulated 13.0% CP level was not possible to include with the 40% wet corn gluten feed level, the 20% and 30% wet corn gluten feed levels were combined for nonlinear (breakpoint) analysis. A breakpoint of 8.6% DIP (13.8 and 14.0% CP for 20% and 30% wet corn gluten feed, respectively) was determined for ADG, and a breakpoint of 8.4% DIP (13.6% and 13.8% CP for 20% and 30% wet corn gluten feed, respectively) was determined for feed:gain. Metabolizable protein and DIP levels for Trial 3 (Table 5) were predicted by the 2000 NRC beef model using microbial efficiency values determined by balancing DIP requirements, as determined by non-linear analysis of feed:gain against DIP for combined wet corn gluten feed levels of 20% and 30%

**Table 4. Effect of wet corn gluten feed and CP level on feedlot performance.**

| Wet corn gluten feed: | 0% | 20% | | | 30% | | | 40% | | SE |
|---|---|---|---|---|---|---|---|---|---|---|
| CP: | 13.9% | 13.4% | 14.1% | 14.8% | 13.5% | 14.2% | 14.9% | 14.5% | 15.0% | |
| Initial weight, lb | 635 | 635 | 635 | 632 | 633 | 633 | 634 | 634 | 634 | 1.1 |
| ADG, lb[a,b] | 3.42 | 3.55 | 3.69 | 3.79 | 3.45 | 3.76 | 3.65 | 3.51 | 3.57 | 0.08 |
| DMI, lb/day[c] | 19.8 | 20.1 | 20.6 | 21.1 | 20.6 | 21.3 | 20.6 | 20.7 | 20.9 | 0.3 |
| Feed:gain[a,b] | 5.80 | 5.65 | 5.60 | 5.56 | 5.97 | 5.66 | 5.66 | 5.90 | 5.85 | 0.10 |
| Hot carcass weight, lb[a,b] | 776 | 792 | 806 | 815 | 779 | 812 | 802 | 786 | 793 | 8 |
| Fat thickness, in | 0.48 | 0.47 | 0.46 | 0.50 | 0.47 | 0.52 | 0.48 | 0.44 | 0.51 | 0.02 |
| Marbling[d] | 529 | 539 | 522 | 541 | 529 | 548 | 522 | 503 | 540 | 13 |
| Ribeye area, $in^2$ | 13.2 | 13.7 | 13.4 | 13.7 | 13.1 | 13.5 | 13.9 | 13.6 | 13.5 | 0.2 |
| Yield grade | 2.23 | 2.27 | 2.21 | 2.30 | 2.30 | 2.57 | 2.23 | 2.13 | 2.44 | 0.11 |
| Choice + Prime, %[e] | 64.1 | 65.8 | 66.7 | 80.0 | 52.5 | 71.8 | 64.1 | 50.0 | 69.2 | — |

[a]Quadratic effect of wet corn gluten feed level ($P < 0.05$).
[b]Linear effect of CP level ($P < 0.05$).
[c]Linear effect of wet corn gluten feed level ($P < 0.05$).
[d]Marbling score: 500 = small (low choice), 600 = modest (average choice).
[e]Not analyzed for effect of wet corn gluten feed or CP level.

**Table 5. Predicted energy and protein levels for Trial 3.**

| Treatment | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Wet corn gluten feed: | 0% | 20% | | | 30% | | | 40% | |
| CP: | 13.9% | 13.4% | 14.1% | 14.8% | 13.5% | 14.2% | 14.9% | 14.5% | 15.0% |
| NEm | 1.04 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 |
| NEg | 0.72 | 0.72 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.70 | 0.70 |
| Metabolizable Protein, g/day | | | | | | | | | |
| Supplied | 802 | 865 | 884 | 903 | 910 | 939 | 906 | 934 | 941 |
| Required | 745 | 764 | 784 | 798 | 749 | 794 | 779 | 759 | 767 |
| Balance | 57 | 101 | 100 | 105 | 161 | 145 | 127 | 175 | 174 |
| Degradable Protein, g/day | | | | | | | | | |
| Supplied | 808 | 742 | 827 | 917 | 755 | 849 | 888 | 838 | 897 |
| Required | 706 | 754 | 771 | 788 | 791 | 816 | 787 | 809 | 815 |
| Balance | 102 | -12 | 56 | 129 | -36 | 33 | 101 | 29 | 82 |

of diet DM. Inadequate DIP supply was indicated for 20% wet corn gluten feed at 13.4% CP and 30% wet corn gluten feed at 13.5% CP.

The NRC predictions suggest the CP requirement for the 20% and 30% wet corn gluten feed levels is approximately 13.7%. There was a small response in efficiency (Table 4) for the 20% level of wet corn gluten feed when CP was increased above 14.1%, but no response with a similar increase for the 30% wet corn gluten feed level.

The results of this trial indicate the level of wet corn gluten feed to include in steam-flaked corn based finishing diets to optimize ADG, feed efficiency, and hot carcass weight of steer calves is in the order of 20% to 30% of diet DM. It is important to note that the effect of wet corn gluten feed on observed animal performance means should only be evaluated at the higher CP levels, where DIP was not limiting. Predicted treatment means were remarkably similar for hot carcass weight (not shown) and ADG between the 20% and 30% wet corn gluten feed treatments. Additionally, if wet corn gluten feed is priced lower than corn, the lower price of wet corn gluten feed may justify higher levels of inclusion as the economic benefits may outweigh small losses in performance.

The optimal CP level was not determined in this trial as responses to supplemental CP were linear, however, it would appear to be as high as 15.0% CP, which was the highest level evaluated. The high requirement for CP indicated may be explained through increased ruminal fermentation of steam-flaked corn when compared to dry rolled corn, and the effectiveness of wet corn gluten feed in raising the rumen pH of cattle fed high concentrate diets. Both increased rumen fermentation and elevated pH allow for increased bacterial activity and crude protein synthesis, allowing for improved animal performance as a result of increased energy availability, but requiring higher levels of DIP, as observed in this trial.

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