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Solvent-Extracted Germ Meal, Corn Bran and Steep Liquor Blends for Finishing Steers

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Solvent-extracted germ meal can be an effective ingredient for finishing cattle and may interact with steep liquor/distillers solubles-corn bran blends to improve efficiency.

Summary

Three trials evaluated solvent-extracted germ meal for finishing ruminants. Dry corn bran and steep liquor/distillers solubles were fed in combination with solvent-extracted germ meal to evaluate interactions of byproduct blends. Byproducts enhanced intake and gain relative to dry-rolled corn diets. Adding tallow to byproduct diets increased efficiency. Feeding solvent-extracted germ meal with steep liquor heightened performance, but the benefit diminished when steep liquor level reached 30% of dry matter. Including solvent-extracted germ meal with wet corn gluten feed influenced neither daily gain nor intake. Results show solvent-extracted germ meal, either alone or blended with steep liquor/distillers solubles and dry corn bran, is an effective energy source for finishing cattle.

Introduction

The process of wet milling corn yields fructose or ethanol from corn starch and oil from corn germ. Byproducts of the wet milling industry include dry corn bran, steep liquor, distillers solubles and solvent-extracted germ meal. After the oil is removed from corn germ, solvent-extracted germ meal may be marketed as a component of corn gluten

feed or sold as a feed ingredient.

Finishing cattle can be more efficient when corn byproducts are fed in combination with dry-rolled corn compared with dry-rolled corn alone. Replacing a portion of the dietary starch from corn with the fibrous energy of corn byproducts may alleviate the severity of subacute acidosis. However, different ratios of solvent-extracted germ meal, dry corn bran and steep liquor may influence cattle performance due to dietary energy content and effects on intake. The objectives of this research were: 1) to determine performance and intake associated with solvent-extracted germ meal diets with and without steep liquor/distillers solubles; and 2) to ascertain if solvent-extracted germ meal could serve as a component of wet corn gluten feed when blended with dry corn bran and steep liquor.

Procedure

Trial 1

Large framed steer calves (n=160, 595 lb) were used in a finishing trial averaging 169 days. Solvent-extracted germ meal (GM), with and without corn steep liquor/distillers solubles (ST), was evaluated relative to diets containing dry-rolled corn (DRC) and wet corn

gluten feed (WCGF). Nutrient composition of GM was 91% DM, 21% CP, 60% NDF, .04% Ca, .33% P and .38% K. Calves were blocked by weight and randomly assigned to one of four treatments. Treatments were DRC control, or either 9% GM, 19%GM+19%ST or 38% WCGF replacing DRC. Final finishing diets contained 92.5% concentrate (Table 1). The WCGF used in this trial was produced by Cargill Corn Milling, Blair, NE. Calves were acclimated to finishing diets with four adaptation diets containing 45, 35, 25 and 15% roughage, fed for 3, 7, 7 and 7 days, respectively. Steers were implanted with Revalor-S on day 1 and day 90 of the trial and fed once daily in groups of 10 animals per pen. Diets were formulated to contain a minimum of 11.5% CP and to meet the rumen degradable protein requirement (TDN × .081) according to 1996 NRC Nutrient Requirements of Beef Cattle.

Trial 2

Medium framed yearling steers (n=60, 780 lb) were used in a 118-day finishing trial to evaluate combinations of GM and ST. The trial was initiated on August 8, 1996 when steers were removed from smooth brome grass pastures. Yearlings were assigned randomly to one of 10 dietary treatments, allow-

Table 1. Composition of diets used in Trial 1.

| Item | Diets (% of DM) ^a | | | |
|-------------------------|------------------------------|------|---------|-------------|
| | DRC | 9%GM | 38%WCGF | 19%GM,19%ST |
| Dry-rolled corn | 83.5 | 74.5 | 50.3 | 50.3 |
| Ground corncobs | 7.5 | 7.5 | 7.5 | 7.5 |
| Wet corn gluten feed | — | — | 38.2 | — |
| Germ meal | — | 9.0 | — | 19.1 |
| Steep | — | — | — | 19.1 |
| Liquid 32 ^b | 5.0 | 5.0 | — | — |
| Supplement ^c | 4.0 | 4.0 | 4.0 | 4.0 |

^aDRC = dry-rolled corn control, GM = solvent-extracted germ meal, WCGF = wet corn gluten feed, ST = steep liquor/distillers solubles.

^bMolasses, urea supplement with 50% CP (DM basis).

^cContains minerals, vitamins, Rumensin and Tylan in a finely ground corn carrier.

ing six animals per treatment. Treatments consisted of a DRC control and combinations (% of diet DM) of either 0, 15 or 30% ST blended with either 15, 30 or 45% GM to replace an equal proportion of the DRC dry matter. Steers were housed in a covered confinement facility with southern exposure and individually fed once daily using Calan gates. Blends of GM and ST in ratios of 50:50, 75:25, 67:33 and 60:40 (DM basis) were mixed the day before feeding. This allowed the ST to permeate the GM, simulating an equilibrated blend which had been produced at the mill and transported to the feedlot. Initial mixes were used as individual ingredients in diet preparation. Additional ST and all other ingredients within each treatment were individually weighed and mixed using a Data Ranger at feeding.

Steers were implanted with Revalor-S on day 1 of the study. Adaptation to the high-concentrate diets was accomplished over 21 days. Adaptation diets contained 45, 35, 25 and 15% ground alfalfa hay (DM basis) and were fed for 3, 4, 7 and 7 days, respectively. The ratios of dry-rolled corn to the ST:GM blends were maintained throughout the adaptation diets. Finishing diets contained 7.5% ground alfalfa hay, 25 g/ton Rumensin, 10 g/ton Tylan, trace minerals, supplemental vitamins A, D, and E and were formulated to provide at least 12.0% CP, .7% Ca, .35% P and .6% K (DM basis).

Trial 3

Large framed steer calves (n=306, 659 lb) were fed for an average of 153 days to determine the performance when fed eight different blends of ST, GM and/or dry corn bran (BR) replacing a portion of the DRC in a 92.5% concentrate finishing diet. Cattle were blocked by weight into one of four blocks and randomly assigned to treatment. Two blocks had eight steers per pen; the remaining blocks contained nine, yielding four pens with 34 steers per treatment. Calves were implanted with Revalor-S on day 1 and re-implanted on day 68. Diets were formulated to provide a minimum of 12.5% CP, .7% Ca, .3% P and .6% K and contained 25 g/ton Rumensin and 10 g/ton Tylan (Table 2). Treatments were: 1) DRC control; 2) 67% BR, 33% ST; 3) 67% GM, 33% ST; 4) 50% BR, 50% ST; 5) 50% GM, 50% ST; 6) 50% ST, 25% BR, 25% GM; 7) 50% ST, 25% BR, 25% GM+fat (tallow at 3% of dietary DM); 8) 33% BR, 33% GM, 33% ST; and 9) 33% BR, 33% GM, 33% ST, +fat. Byproduct blends were included to comprise 22.5% of diet DM. As in Trial 2, cattle were adapted to grain using 45, 35, 25 and 15% roughage diets. However, in Trial 3 calves were fed each adaptation diet for 7 days, and only the DRC to alfalfa ratio was changed with each diet. The dietary percentage of ST, GM and BR blends (22.5% of DM) was consistent throughout the trial.

For initial weights in all trials, steers were limit fed at 2% of body weight (DM basis) for 5 days to reduce fill differences and weights were obtained before feeding on two consecutive days. Final live weights were determined by dividing hot carcass weight by a common estimated dressing percentage (62). Data were also collected for fat thickness over the twelfth rib, quality grade yield grade, and the incidence of liver abscesses.

Results

Trial 1

Dry matter intake and ADG of cattle fed the 38% WCGF treatment were higher ($P<.05$) than all other treatments (Table 3). However, there were no differences among other treatments for daily gain or intake. Average daily gain of cattle fed the GM:ST blend was greater ($P<.05$) than that for steers consuming GM without ST, which had gains similar to the DRC control. Orts collected from pens receiving the 9% GM diet appeared to have a higher proportion of GM than was present in the initial diet. It is unclear whether steers were actively sorting out the GM or if the dry, finely ground product was settling in the bunk. In either case, the integrity of the dietary balance of this treatment was compromised with the diminished consumption of GM, which

(Continued on next page)

Table 2. Diets used for finishing calves in Trial 3.

| Item | Diet (% of DM) ^a | | | | | | | | |
|-------------------------|-----------------------------|----------------|----------------|----------------|----------------|-------------------------|----------------------------------|-------------------------|----------------------------------|
| | DRC | 67%BR 33%ST | 67%GM 33%ST | 50%BR 50%ST | 50%GM 50%ST | 50%ST 25%BR 25%GM | 50%ST 25%BR 25%GM + Fat | 33%BR 33%GM 33%ST | 33%BR 33%GM 33%ST + Fat |
| Dry-rolled corn | 84.7 | 62.9 | 63.2 | 63.2 | 63.2 | 63.2 | 60.2 | 63.2 | 60.2 |
| Alfalfa hay | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 |
| Dry corn bran | — | 15.0 | — | 11.25 | — | 5.62 | 5.62 | 7.5 | 7.5 |
| Steep | — | 7.5 | 7.5 | 11.25 | 11.25 | 11.25 | 11.25 | 7.5 | 7.5 |
| Germ meal | — | — | 15.0 | — | 11.25 | 5.63 | 5.63 | 7.5 | 7.5 |
| Molasses | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Tallow | — | — | — | — | — | — | 3.0 | — | 3.0 |
| Supplement ^b | 2.8 | 2.1 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 |

^aDRC = dry-rolled corn, BR = dry corn bran, ST = steep liquor/distillers solubles, GM = solvent-extracted germ meal, Fat = tallow.

^bContains Vitamin A, D, and E premix, minerals, Rumensin-80 and Tylan.

could have lowered CP intake while increasing starch consumption.

The DRC control treatment exhibited a less efficient feed/gain ratio ($P<.05$) than treatments containing corn byproducts. Feed-to-gain ratio for 19% GM, 19% ST (5.37) and 38% WCGF (5.51) treatments did not differ, indicating that in this trial, 50:50 blends of both BR and GM with ST had similar energy values. Feed-to-gain ratio attributed to the 9% GM diet was numerically greater than, but not different from, the 38% WCGF treatment ($P=.23$).

When ST and GM were combined, the GM was adhered to other dietary ingredients by the ST, diminishing the separation potential and enhancing performance. Carcass quality and yield grades were greatest for the 38% WCGF diets but did not differ among other treatments.

Trial 2

Due to diet separation problems, Trial 2 was designed to test for a possible GM effect on intake, and to further investigate the possibility of a dietary interaction between GM and ST. A GM by ST level interaction was found for both average daily gain and DM intake (P<.05). Steers consuming 0 and 15% ST gained similarly across all levels of GM (Figure 1). Gains associated with the 30% ST treatment declined at the 30 and 45% GM levels. Means for DM intake did not differ among the 15, 30, or 45% GM treatments within the 0 and 15% ST levels. However, a linear decrease in DM intake was demonstrated within the 30% ST treatment as level of GM increased from 15 to 45% ($P<.05$) (Figure 2). An additional ST by GM level interaction was observed for quality grade, with 30%ST, 30%GM and 30%ST, 45%GM treatments exhibiting the lowest values for carcass quality grade.

Average daily gain for DRC (3.12 lb) was exceeded by the 15 (3.97 lb), 30 (3.90 lb), and 45% (3.93 lb) GM levels with the inclusion of 15% ST ($P<.05$). No differences were observed among DRC and GM, ST blends at any level for feed conversion. No liver abscesses were encountered in this study.

Table 3. Effect of diets on calf performance in Trial 1.

| Item | Diets ^a | | | |
|----------------------------|--------------------|--------------------|--------------------|--------------------|
| | DRC | 9% GM | 38% WCGF | 19% GM, 19% ST |
| Daily gain, lb | 3.36 ^b | 3.36 ^b | 3.90 ^c | 3.66 ^d |
| DM intake, lb/day | 19.72 ^b | 18.99 ^b | 21.48 ^c | 19.67 ^b |
| Feed/gain ^e | 5.88 ^b | 5.64 ^c | 5.51 ^{cd} | 5.37 ^d |
| Quality grade ^f | 18.47 ^b | 18.12 ^b | 18.95 ^c | 18.38 ^b |
| Yield grade | 2.3 ^b | 2.2 ^b | 2.8 ^c | 2.5 ^d |
| Fat thickness, in | .43 ^b | .43 ^b | .53 ^c | .47 ^{bc} |

^aDRC = Dry-rolled corn control, GM = solvent-extracted germ meal, WCGF = wet corn gluten feed, ST = steep liquor/distillers solubles.

^{b,c,d}Means within row with unlike superscript differ $P<.05$.

^eAnalyzed as gain to feed, the reciprocal of feed to gain.

^fHigh select = 18, low choice = 19.

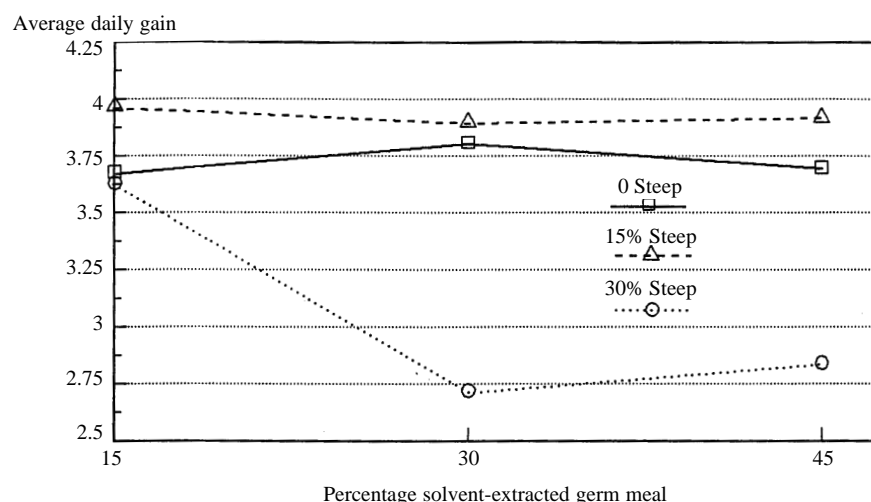


Figure 1. Solvent-extracted germ meal by steep liquor/distillers solubles level interaction exhibited for ADG by yearlings steers in Trial 2 ($P<.05$). Dry-rolled corn control cattle gained an average of 3.12 lb per day.

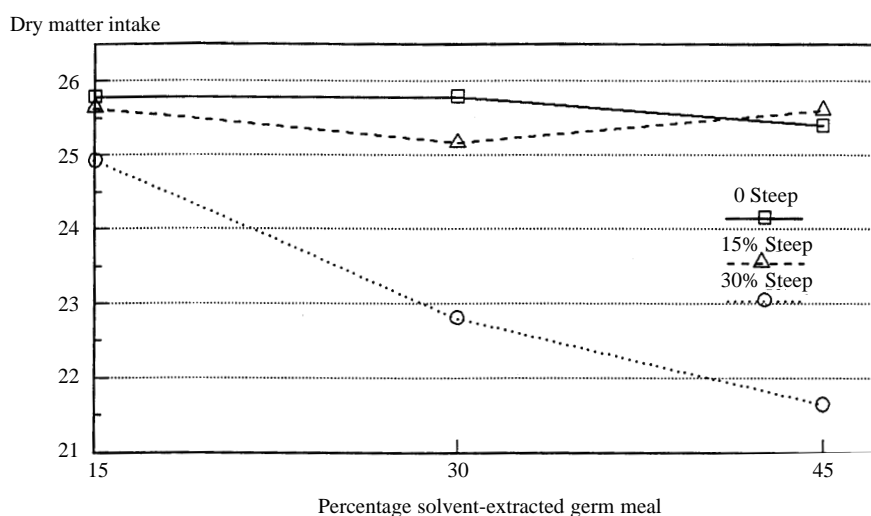


Figure 2. Solvent-extracted germ meal by steep liquor/distillers solubles level interaction exhibited for daily DM intake in Trial 2. A linear decrease in DM intake occurred as solvent-extracted germ meal concentration increased within the 30% steep liquor level ($P<.05$). Mean daily DM intake for the dry-rolled corn control treatment was 23.25 lb.

Table 4. Effect of corn byproduct blends on calf performance in Trial 3.

| Item | Diet (% of DM) ^a | | | | | | | | |
|---------------------------------|-----------------------------|----------------|----------------|----------------|----------------|-------------------------|----------------------------------|-------------------------|----------------------------------|
| | DRC | 67%BR 33%ST | 67%GM 33%ST | 50%BR 50%ST | 50%GM 50%ST | 50%ST 25%BR 25%GM | 50%ST 25%BR 25%GM + Fat | 33%BR 33%GM 33%ST | 33%BR 33%GM 33%ST + Fat |
| Daily gain, lb ^b | 3.74 | 3.80 | 3.95 | 3.82 | 3.99 | 3.86 | 3.92 | 3.85 | 4.02 |
| DM intake, lb/day ^{cd} | 22.50 | 23.31 | 22.85 | 22.67 | 22.18 | 22.02 | 22.14 | 22.16 | 22.08 |
| Feed/gain ^{def} | 6.02 | 6.13 | 5.78 | 5.93 | 5.56 | 5.70 | 5.65 | 5.76 | 5.49 |
| Quality grade ^g | 18.5 | 18.7 | 18.7 | 18.9 | 18.5 | 18.7 | 18.8 | 18.2 | 18.4 |
| Yield grade | 2.3 | 2.6 | 2.6 | 2.6 | 2.4 | 2.5 | 2.6 | 2.1 | 2.6 |
| Fat thickness, in | .46 | .50 | .53 | .50 | .47 | .51 | .54 | .46 | .50 |

^aDRC = dry-rolled corn, BR = dry corn bran, ST = steep liquor/distillers solubles, GM = solvent-extracted germ meal, Fat = tallow.

^bLinear BR vs GM level $P=.01$. DRC vs byproduct diets without tallow $P=.10$.

^cQuadratic BR vs GM level $P<.01$.

^d33% vs 50% ST $P<.05$.

^eLinear BR vs GM level $P<.01$.

^fAnalyzed as gain/feed, the reciprocal of feed/gain.

^g18 = high select, 19 = low choice.

Trial 3

Compared to the combined group of corn byproduct blends without added tallow, the DRC treatment tended to elicit a lower average daily gain ($P=.10$). However, neither DM intake nor feed-to-gain ratio was different when means for byproduct blends without tallow were pooled. Combining and contrasting treatments based on ST level (33 vs 50%) indicated a decrease in DM intake, as well as enhanced feed efficiency with increasing level of ST (Table 4). This analysis excluded the DRC treatment and those containing 3% added tallow. No byproduct blend by tallow interaction existed, therefore data were combined for the 50%ST, 25%BR, 25%GM and 33%BR, 33%GM, 33%ST diets and contrasted with those containing added tallow. A significant increase in average daily gain was achieved when cattle consumed tallow (3% of DM) in addition to the BR, ST, GM combinations at 22.5% of dietary DM ($P=.05$). Feed-to-gain ratio also decreased within these combined treatments with tallow addition ($P=.06$).

To examine the influence of BR and GM level on calf performance, means were analyzed after combining these two ingredients across treatments into high (67 and 50%), medium (33 and 25%) and low (0%) BR and/or ST cat-

egories. A quadratic response was observed for DM intake as GM concentration moved from low to high levels ($P<.01$). Intake means for high, medium and low levels of GM were 22.5, 22.1 and 23.0 lb per day. Average daily gain and feed efficiency increased linearly for the low (3.81 lb, 6.03), medium (3.86 lb, 5.73) and high (3.97 lb, 5.67) levels of GM ($P=.01$, $P<.01$). These responses indicated diets containing GM may possess more energy than those with BR. Additionally, high intake obtained with high BR diets may have diminished efficiency.

Results of these trials demonstrate the value of corn byproducts for finishing cattle relative to DRC. However, both intake and feed efficiency were influenced by the composition of the BR, GM and ST blend. Consumption of BR diets tended to be greater than when GM was included at the same dietary level. Dry corn bran lacks the readily fermentable carbohydrates present in DRC, ST and GM; it provides lower dietary energy content while it simultaneously diminishes the incidence of acidosis and allows for heightened consumption. In Trial 2, GM alone numerically enhanced performance above the DRC diet. Conversely, in Trial 1, penned cattle responded to GM at 9% of diet DM with means for intake and daily gain similar to those obtained with DRC. When comparing data from Trials 1 and

2, it is unclear whether GM as a single ingredient provides an improvement in performance over that exhibited by DRC alone.

When GM was combined with ST, the response in intake and daily gain was not consistent as ST level increased. Performance of cattle in Trial 1 did not appear diminished when ST was included at 19% of DM and blended with GM. In Trial 2, however, cattle performance declined between the 15 and 30% levels of ST when GM level reached 30 and 45%. Feeding GM with ST at lower dietary concentration in Trial 3 demonstrated a possible beneficial association between these two byproducts when they comprise a small portion of the DM.

Treatments including three-way combinations of BR, ST and GM elicited satisfactory intake and daily gain, indicating these three byproducts combined may serve as an alternative to feeding WCGF alone. Additions of tallow to these blends further enhanced performance and showed tallow can be combined with corn byproduct blends in small quantities without adversely effecting dietary characteristics.

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