Relationship between Dietary Total Digestible Nutrients and Digestible Organic Matter in Beef Cattle Finishing and Growing Diets With or Without Distillers Grains

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Summary and Implications

The relationship between organic matter digestibility and total digestible nutrients is unestablished for diets containing distillers grains. Three cattle digestion studies were used to evaluate the relationship between total digestible nutrients and digestible organic matter. Results suggest digestible organic matter is consistent relative to total digestible nutrients content for traditional, corn based diets. In finishing and growing diets containing distillers grains additional digestible energy supplied by distillers grains is not accounted for when evaluating only digestible organic matter. Measuring digestible energy content of diets used in digestion trials is essential.

Introduction

Total digestible nutrients (TDN) are directly related to digestible energy (DE). Then, TDN can be converted to DE using 1 lb of TDN equal to 2 Mcal of DE. Previously, TDN was based on proximate analysis, which is no longer commonly used. These analyses were also based on diets containing primarily corn, fat, and alfalfa, but none containing distillers grains. Organic matter digestibility (OMD) is related to TDN and is commonly measured in digestion studies to estimate feeding values. However, the relationship between OMD and TDN is unestablished for diets containing distillers grains. When the amount of wet distillers grains plus solubles (WDGS) is increased in a diet there is an increase in feed efficiency but a decrease in OMD. Total energy content of the feed and feces can be measured using bomb calorimetry to directly measure DE. The objective of this study was to compare digested organic matter (DIGOM), determined by previous digestibility trials utilizing diets with or without distillers grains, DE, and calculated TDN values using bomb calorimetry.

Procedure

This study utilized three previously conducted digestion trials where total tract collection and OM analysis of feed and feces were measured to determine OMD. Organic matter digestibility values were then multiplied by dietary OM content to determine digested organic matter (DIGOM, % DM). Dietary DE was calculated from heat of combustion of feed and feces, measured using a bomb calorimeter. Conversion of DE to TDN was assumed to be 2.0 Mcal DE / lb TDN. Regression models were developed using GLM Procedures of SAS. Digestion data were analyzed using the Mixed Procedures of SAS with treatment as a fixed effect and steer as experimental unit. Comparisons were made across and within experiments.

Description of Experiments

The first experiment fed a basal diet consisting of 40% Sweet Bran®, 45% high moisture corn (45% HMC), 10% corn silage, and 5% supplement (DM basis) with or without enzyme. The second experiment (18% MDGS) had four dietary treatments. The negative control (negcontrol) contained 60% untreated corn stover, 18% MDGS, 18% distillers solubles and 4% supplement (DM basis). The positive control (poscontrol) consisted of 60% CaO treated corn stover, 18% MDGS, 18% distillers solubles, and 4% supplement. The third treatment (pelletC) was a pellet containing the same proportions of CaO treated corn stover, solubles, MDGS and supplement. Treatment four (pelletS) was also a pellet containing the same proportions of CaO treated corn stover, solubles, DDG, and supplement. The corn stover for this treatment was harvested using a single pass round baler pulled behind the combine. The corn residue that was left was raked into wind rows and baled with a conventional square baler. The third experiment used five dietary treatments comparing an 80% DRC-based diet (Corn) with one of two supplemental fat sources (Tallow or Cornoil) to diets with 25.5% distillers solubles (Solubles), or 56% wet DGS (WDGS).

Regression

Regression was used to relate digestible OM to TDN. The initial model included experiment, animal within experiment, and treatment within experiment. Individual points were used to represent animal within period for each experiment in Figures 2–4. For Exp. 1 and 2, a combined treatment average was used for each experiment and experiments will be henceforth referred to as 45% HMC and 18% MDGS, respectively. Regression models for the relationship between the differences in DIGOM, TDN, and GE were developed used treatment average as the observation.

Results

Intercepts for a unified regression model were not significant ($P = 0.316$). A significant treatment within experiment effect ($P < 0.01$) resulted in independent regression models for each experiment. An isopleth was indicated with a dotted line to show relative differences of slope. Treatments for Exp. 1 were significantly different ($P < 0.01$) for DIGOM relative to TDN. However, Exp. 1 showed no treatment effect for DIGOM. Therefore, a single slope with a linear relationship was used (Figure 1) and designated as a treatment average (45% HMC) for further analysis. Treatments for Exp. 2 were significantly different ($P < 0.01$) for DIGOM relative to TDN. However, Exp. 2 showed no treatment effect for DIGOM. Therefore,

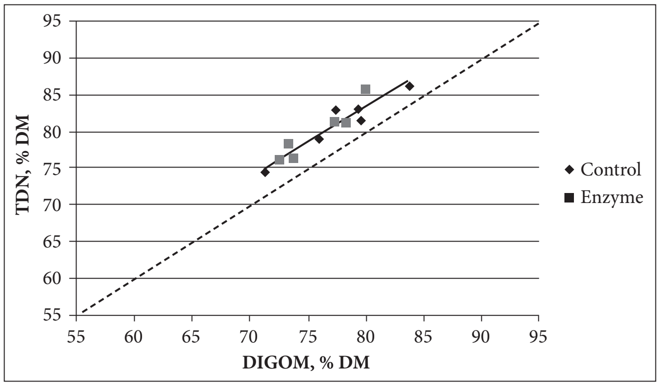

Figure 1. TDN vs DIGOM in 2 finishing diets without DGS (Exp. 1). Control (diamonds) and enzyme (squares) data are shown in the graph where individual data points indicate animal as the experimental unit. The regression equation for the data was TDN = [0.967 (±0.106) × DIGOM] + 6.16 (±8.20) % (R^2 =0.892).

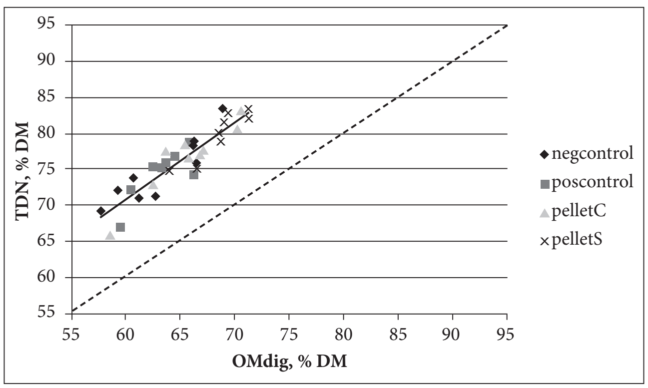

Figure 2. TDN vs DIGOM of growing diets with DGS (Exp. 2). NEGCONTROL (diamond), POSCONTROL (square), pelletC (triangle), and pelletS (exes) data are shown in the graph where individual data points indicate animal as the experimental unit. The regression equation for the data was TDN = [1.10 (±0.0786) × DIGOM] + 4.59 (±5.14) % (R^2 =0.852).

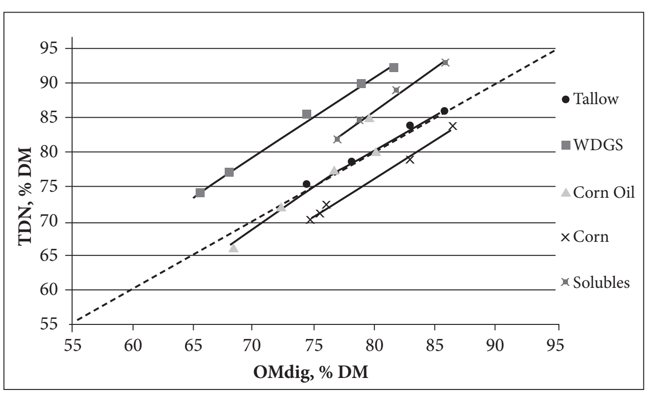

Figure 3. TDN vs DIGOM in 5 finishing diets (Exp. 3). Tallow (circles), WDGS (squares), Corn Oil (triangles), Corn (exes), and Solubles (asterisks) data are shown in the graph where individual data points indicate animal as the experimental unit. The regression equation for the Tallow treatment was TDN = [0.990 (±0.0433) × DIGOM] + 1.09(±3.44) % (R^2 =0.994). The regression equation for the WDGS treatment was TDN = [1.15 (±0.0471) × DIGOM]-0.887(±3.49) % (R^2 =0.995). The regression equation for the Corn Oil treatment was TDN = [1.10 (±0.0712) × DIGOM]-7.70(±5.44) % (R^2 =0.987). The regression equation for the Corn treatment was TDN = [1.11 (±0.0519) × DIGOM]-12.5(±4.12) % (r2 =0.993). The regression equation for the Solubles treatment was TDN = [1.24 (±0.0833) × DIGOM]-13.9(±6.72) % (R^2 =0.987).

a single slope with a linear relationship was used (Figure 2) and designated as a treatment average (18% MDGS) for further analysis. In Exp. 3, there was a tendency for a treatment effect (*P* > 0.14). Therefore treatments were evaluated using separate regression lines (Figure 3) and treatments remained separate for further analysis (Corn, CornOil, Tallow, Solubles, WDGS).

The difference between TDN (% of DM) and DIGOM (% of DM) was greatest for the 18% MDGS (Exp. 2) with 11.1 percentage units (PPT) difference (Table 1). The WDGS treatment followed with 10.0 PPT difference. The solubles, 45% HMC (Exp. 1), and Tallow treatments were 5.9, 3.6, and 0.3 PPT difference, respectively. Corn oil and corn treatments had greater DIGOM than TDN showing a PPT difference of-0.4 and-4.0, respectively.

There were no significant differences for OM intake (kg) across all treatments (*P* = 0.88; Table 2). There were no significant differences in energy intake (Mcal) across all treatments (*P* = 0.28). However, OM excreted (kg) was significantly different (*P* < 0.01), with WDGS and 18%MDGS treatments having the greatest OM excreted, Corn, 45% HMC, Corn Oil and Tallow being intermediate, and solubles having the least OM excreted. There were significant differences (*P* < 0.01) in energy excreted (Mcal) with WDGS and 18% MDGS having the greatest energy excreted, Corn, Corn Oil, Tallow, and 45% HMC being intermediate, and Solubles having the least energy excreted. The ratio for consumed energy relative to consumed OM was different across treatments (*P* < 0.01), with WDGS and 18% MDGS having the greatest ratio, solubles the next greatest ratio, followed by 45% HMC. Corn oil and tallow had the fourth greatest ratio and Corn had the lowest ratio. The ratio for excreted OM relative to excreted energy was significantly different (*P* < 0.01), with solubles and WDGS having the greatest ratio, corn, corn oil, tallow, and 45% HMC being intermediate, and 18% MDGS having the lowest ratio (Table 2).

The DIGOM is consistent relative to TDN content of traditional corn based diets. Results from Exp. 2 and 3 with diets containing DGS showed there was some portion of DE that was not accounted for when using only DIGOM. Additional DE is likely due to the protein and fat content of DGS which

Table 1. Average TDN and DIGOM for treatments for experiments 1–3.

Treatments[1]	TDN[2], % of DM	DIGOM[2], % of DM	Difference[3]
Exp. 1			
45% HMC	80.5	76.9	3.6
Exp. 2			
18% MDGS	76.4	65.3	11.1
Exp. 3			
Corn	75.2	79.2	-4.0
CornOil	75.9	76.2	-0.4
Tallow	79.7	79.3	0.3
Solubles	86.6	80.7	5.9
WDGS[4]	83.7	73.8	10.0

[1]Treatments from Exp. 1; Contains control and enzyme treatments which both contain 45% HMC; HMC: High moisture corn; Treatments from Exp. 2; Contains poscontrol, negcontrol, pelletS and pellet which all contain 18% MDGS; MDGS: Modified distillers grains; Treatments from Exp. 3; WDGS: Wet distillers grains
[2]Treatment average across animal and period; TDN: Total digestible nutrients; DIGOM: Digested organic matter
[3] Percentage unit difference
[4] 56% inclusion (DM basis) of WDGS in the diet

Table 2. Difference in diet and fecal energy relative to OM[1] content for all experiment treatments.

	Treatment								
	Corn	45% HMC[2]	Corn Oil	Tallow	Solubles	WDGS[3]	18% MDGS[4]	SEM	*P*-Value
Consumed									
OM, lb	10.7	9.53	9.34	10.0	9.34	10.0	9.93	0.84	0.88
Energy, Mcal	46.4	44.9	42.7	45.6	45.1	51.0	50.9	4.23	0.28
Excreted									
OM, lb	1.92[bc]	1.80[bc]	2.01[bc]	1.87[bc]	1.35[c]	2.32[ab]	2.71[a]	0.30	<0.01
Energy, Mcal	9.61[bc]	9.17[bc]	10.5[bc]	9.58[bc]	7.30[c]	12.4[ab]	13.5[a]	1.49	<0.01
Energy, Mcal/lb OM [5]									
Consumed	4.32[e]	4.72[c]	4.56[d]	4.56[d]	4.83[b]	5.07[a]	5.11[a]	0.025	<0.01
Excreted	5.00[bc]	5.11[bc]	5.25[ab]	5.18[abc]	5.40[a]	5.36[a]	5.00[c]	0.087	<0.01

[1] OM: Organic matter
[2]Treatment average for Exp. 1; Contains control and enzyme treatments which both contain 45% HMC; HMC: High moisture corn
[3] 56% inclusion (DM basis) of WDGS in the diet
[4] Treatment average for Exp. 2; Contains poscontrol, negcontrol, pelletS and pelletC which all contain 18% MDGS; MDGS: Modified distillers grains
[5] Consumed: Consumed energy (Mcal) was divided by consumed OM (lb). Excreted: Excreted energy (Mcal) was divided by consumed OM (lb).

supplies additional energy relative to OM content. All treatments consumed the same amount of OM but varied in energy intake. This was more apparent when expressed as a ratio with energy intake. The average of all treatments in Exp. 2 had the greatest ratio for energy intake relative to OM intake. Conversely, the average of all treatments had the smallest ratio for energy excreted relative to OM excreted. These data suggest that there is more energy being consumed but not being excreted in the feces. The fiber content of DGS could reduce energy supplied, but would remain in feces as OM, which is why greater OM was excreted from treatments containing DGS.

Conclusions

The difference between TDN and DIGOM is much greater for diets containing DGS. When the percent difference between TDN and DIGOM is expressed in terms of GE within an individual experiment, the relationship becomes uniform across diets. Therefore, it is essential to measure digestible energy content of diets in digestion trials, especially diets including distillers grains.

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