Ration Fermentability: Key Factor for Inclusion Level of Distiller’s Grains in Lactation Rations

Opinions vary regarding how much distiller’s grains (DG) can be used effectively in lactation rations. In order to better understand conflicting reports and recommendations about the effect of DG on milk yield we examined 23 studies about DG in the dairy science literature. Inclusion of DG in treatment diets ranged from 4 to 42% of dietary DM across all studies. Our analysis of the entire database, shows that inclusion rate of DG per se did not affect FCMY, MY, MF%, or MP%. However, when the fermentability of rations is considered there were significant changes in milk yield responses to inclusion of DG.

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Dairy farmers and nutritionists often ask how much distiller’s grains (DG) can be used effectively in lactation rations. We hear from consulting nutritionists and dairy farmers that many times more than 5 to 10% DG in rations (about 2 to 6 lb/cow per day; dry basis) reduces milk yield and fat test. In contrast, a report from South Dakota recommended as much as 20% of the ration dry matter (DM) (10 to 13 lb/head per day; 4). In an earlier analysis of research results from the scientific literature as much as 30% of ration DM did not affect milk yield or composition. However, greater than 30% DG reduced feed intake, milk yield, and milk protein content (4). Therefore, we evaluated results of all available lactation studies in the dairy science literature to better understand these conflicting reports and recommendations; and, to learn how to best incorporate DG into lactation rations.

Nutrient concentrations in DG are typically three to four times that of yellow corn because nutrients are concentrated as starch is removed. A typical profile of DG includes (DM basis): 30% crude protein (CP), 0.8% phosphorus (P), 0.4% sulfur (S), 39% neutral detergent fiber (NDF) and 10% fat (3). The fatty acids in DG, as in corn oil, are highly unsaturated, and can be altered by ruminal microbes during fermentation. Rations with a large proportion of highly fermentable carbohydrates can reduce fat-corrected milk yield, most commonly by means of milk fat depression. Specifically, highly fermentable diets alter ruminal metabolism suppressing the complete saturation of unsaturated fatty acids. And so, more...
intermediates of fatty acid metabolism (e.g., certain conjugated linoleic acid isomers) flow from the rumen and are absorbed from the gut. These isomers inhibit milk fatty acid synthesis in the mammary gland causing milk fat depression (2). Besides being high in unsaturated fatty acids, DG contain about 39% NDF which is highly fermentable in the rumen.

Therefore, we evaluated the effects of ration fermentability on lactational performance when rations contained DG. For our analysis, categories of ration fermentability were based on well-accepted nutritional concepts that ruminal fermentability is greater for: 1) forage type --- corn silage vs. alfalfa; 2) grain concentration --- grain (starch) vs. other non-grain feedstuffs; and, 3) grain fermentability --- high-moisture grain vs. dry grain (1).

Method of Analysis

We developed a database from 23 peer-reviewed research articles published from 1982 to 2006. The database included changes (positive or negative responses) in: raw milk yield (MY; unadjusted for components content); 4% fat-corrected milk yield (FCMY); and, milk fat (MF%) and milk protein (MP%) percentages of cows consuming rations containing more than 4% DG (DM basis) compared with a control (ration without DG) within each study. In all cases, DG were substituted for portions of the concentrates in the control ration, not for forages. Initially, we evaluated the effects of increasing DG concentration of the diets on lactational performance using data across all studies (122 total treatment means). Secondly, we evaluated lactational responses to the three factors of ration fermentability --- forage type, grain concentration in the rations containing DG, and grain fermentability.

Inclusion of DG in treatment diets ranged from 4 to 42% of dietary DM across all studies. We classified forage type as alfalfa (greater than 80% of forage DM); mixture (alfalfa and more than 20%, but less than 100% corn silage in forage DM); and, corn silage (sole forage in diet). Besides being high in unsaturated fatty acids, DG contain about 39% NDF which is highly fermentable in the rumen.

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Results

Inclusion Level of DG. Change in yield of 4% fat-corrected milk was not affected by increasing inclusion rate of DG from 4 to 42% of ration DM (Figure 1, page 8). Schingoethe (4) cited an unpublished analysis by Kalscheur in South Dakota that found similar results. Additionally, in our analysis neither MY, MF%, nor MP% were affected by inclusion rate of DG in the ration, similar to the South Dakota study.

Table 1 shows changes in milk yields and composition as impacted by diet fermentability (forage type, grain concentration, or grain fermentability) by dietary inclusion of distiller’s grains compared with control.

### Table 1. Milk yield and composition changes as impacted by diet fermentability (forage type, grain concentration, or grain fermentability) to dietary inclusion of distiller’s grains compared with control*<sup>a</sup>  

<table>
<thead>
<tr>
<th>Response</th>
<th>Forage Type&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Grain Concentration&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Grain Fermentability&lt;sup&gt;d&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alfalfa</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Mixture</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Corn silage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw milk yield, lb/d</td>
<td>+4.2</td>
<td>+1.4</td>
<td>+2.2</td>
</tr>
<tr>
<td>FCM yield&lt;sup&gt;e&lt;/sup&gt;, lb/d</td>
<td>+5.8</td>
<td>+3.3</td>
<td>+2.5</td>
</tr>
<tr>
<td>Milk fat, %</td>
<td>+0.09</td>
<td>+0.09</td>
<td>+0.05</td>
</tr>
<tr>
<td>Milk protein, %</td>
<td>+0.06</td>
<td>-0.06</td>
<td>-0.02</td>
</tr>
</tbody>
</table>

*<sup>a</sup> Control = ration without distiller’s grains within study.  
<sup>b</sup> Forage type = Alfalfa (greater than 80% of forage DM); Mixture (alfalfa and more than 20%, but less than 100% corn silage in forage DM); and, Corn silage (sole forage in diet).  
<sup>c</sup> Grain concentration = Low (grain content less than or equal to 20% of diet DM) and, High (grain content greater than 20% of diet DM).  
<sup>d</sup> Grain fermentability = Low (high moisture corn as portion of dietary grain); and, High (dry corn sole grain in diet).  
<sup>e</sup> 4% fat-corrected milk yield.
– forage type, grain concentration, and grain fermentability
– significantly affected change in raw MY and FCMY. However, changes in MF% due to the three fermentability factors were not detected.

**Forage Type.** Among forage types, changes in MY and FCMY with added DG compared with control were positive and greatest for alfalfa-based rations, followed by rations with mixtures of alfalfa and corn silage. The changes in MY and FCMY were negative and numerically of greatest magnitude when corn silage was the sole forage in rations (Table 1). The magnitude of these changes due to ration forage type also is largest of the three fermentability factors studied (Table 1). Responses in FCMY differed overall by more than 10 lb/cow per day when the forage base of the ration was alfalfa compared with corn silage. Thus, ration forages with different ruminal fermentability resulted in very different milk yield responses when DG were included in the ration. Changes were not detected in MF% for cows fed rations with DG compared with control due to different ration forage type. However, response of MP% was markedly different by forage type when DG were included in the ration with +0.06, -0.09, to -0.16 percentage units change when forage base was alfalfa, the mixture of alfalfa and corn silage, or only corn silage, respectively.

**Grain Concentration.** Raw MY and FCMY responses (changes) when DG were included in the ration compared with control were greater with low (less than or equal to 20% of ration DM) compared with high (greater than 20% of ration DM) grain concentrations (Table 1). The magnitude of these changes due to grain concentration when DG were included was on the order of +3 lb for FCMY with low grain concentration to -0.5 lb/cow per day with high grain concentration. The magnitude of the difference in FCMY response to grain concentration (almost 4 lb/cow per day) was considerably less compared with the effect of ration forage type as a fermentability factor (about 10 lb/cow per day). This likely is because the contribution of grain to the overall fermentability of the ration decreased as DG were substituted for grain. We did not detect changes in MF% or MP% due to ration grain concentration with DG included.

**Grain Fermentability.** When grain fermentability was low (with dry corn grain) in the ration with DG versus control, changes in MY and FCMY (2.2 to 2.5 lb/cow per day) were greater compared with rations in which high moisture corn (high grain fermentability) was the grain source (Table 1). The MY response was negative with high grain fermentability, but slightly positive for FCMY when DG were included in the ration. Of the three factors of fermentability, grain fermentability resulted in the least magnitude of overall difference (+2.2 lb/cow per day). Nonetheless, these results strongly support the idea that ration fermentability affects the lactational response to DG inclusion.

In our analysis, inclusion of DG did not affect MF%. This result was somewhat unexpected based on observations from field nutritionists and the potential for milk fat depression in rations with higher carbohydrate fermentability and unsaturated fat concentrations. Reasons for the lack of effect of DG on MF% in our analysis are unknown. This result is similar to that of a previous report (4). Overall average milk fat percentage across all experiments in our database was 3.44 ± 0.276% (average ± SD).

**Conclusions and Implications**

- Our analysis of the entire database (results of all studies combined), shows that inclusion rate of DG per se did not affect FCMY, raw MY, MF%, or MP%.

![Figure 1. Increasing distiller’s grains (DG) inclusion versus change in 4% fat-corrected milk yield change across all studies (not statistically significant). Each dot represents a difference in 4% fat-corrected milk yield of cows fed a ration with DG minus those fed a ration with no DG (control) in each trial in the database.](image-url)
However, when the fermentability of rations is considered there are significant changes in FCMY and raw MY responses to inclusion of DG. 

Greater fermentability of the ration forage base (ruminal fermentability of corn silage greater than alfalfa) resulted in lower and sizable negative FCMY and raw MY responses to DG inclusion.

Greater amounts of grain in diets containing DG resulted in lower MY and FCMY responses to DG inclusion.

Greater grain fermentability (high moisture corn greater than dry corn) resulted in lower FCMY and MY responses when DG were included in the ration.

In our analysis, inclusion of DG did not affect change in MF% with any of the three fermentability factors evaluated.

In more fermentable lactation rations with added DG, FCMY and raw MY are reduced significantly compared with the situation in which DG are included in less fermentable rations.

No doubt, the overall fermentability of the ration must be a major consideration, among other criteria, when setting the inclusion level of DG in rations for lactating dairy cows.

References


