Using Distillers Grains in the Dairy Ration[1]

Dr. David J. Schingoethe
Dairy Science Department
South Dakota State University

The feeding of distillers grains to dairy cattle is nothing new; such products have been fed cattle for more than a century. The research article by Loosli et al. (1952) referenced an 1895 Vermont Agricultural Experiment Station Bulletin that reported on the feeding of distillers grains to lactating cows. In many respects, one might say that responses to feeding distillers grains today should be similar to those older studies. That may be correct except for some differences in both distillers grains and cows today versus yesterday. The distillers grains are different today, primarily containing more protein and energy, and today's cows produce much more milk than was produced by their ancestors.

The objective of my presentation is to report the results of recent studies in which distillers grains were fed to dairy cattle. While the emphasis of this presentation is on dried distillers grains, research with both wet and dried products will be reviewed. Generally, I will be referring to corn distillers grains (CDG) because that is what most of the studies with which I am familiar have used; results with distillers grains from other grains would likely be similar. In most cases, the CDG used is dried distillers grains plus solubles (DDGS).

The composition of CDG today, especially products coming from the ethanol plants in the Midwest, contains more protein and energy than older "book" values. For instance, the CDG, both wet and dried, that was used in our SDSU research contained 30 to 36% or more crude protein on a dry matter basis versus the 23% CP for CDG and 25% CP for DDGS values reported in the 1989 nutrient requirements of dairy cattle (NRC, 1989). The new dairy NRC (2001) lists 29.7% CP for DDGS, a number that is close to reality. The net energy for lactation (NE_L) in today's CDG is about 10% higher (~ 1.00 Mcal/lb) than the older values (~ 0.90 Mcal/lb). Contents of fat (~ 9.8%), neutral detergent fiber (~ 39%), and acid detergent fiber (~ 19%) are only slightly different from the older values. Improved efficiencies in fermenting more of the starch that was in the corn to ethanol is likely the reason for these observed changes in the composition of CDG.

Another nutritional consideration when feeding distillers grains or many other co-product feeds is the phosphorus content. Dried CDG contains approximately 0.43% P and DDGS contains approximately 0.83% P, reflecting the high P content (1.37%) of distillers solubles. This high P content can be an advantage because it can allow one to decrease the amount of supplemental P normally added to the diet. Or, it can be a disadvantage if nutrient management concerns about high P content of manure can't be avoided by decreasing amounts of P from other feed sources.

---

[1] Presented at the National Corn Growers Association Ethanol Co-Products Workshop "DDGS: Issues to Opportunities", November 7, 2001, Lincoln, NE.

Protein in Corn Distillers Grains

Corn distillers grains is a good source of ruminally undegradable protein (RUP). The reported values of 55% of CP as RUP is probably an appropriate figure to use in most cases. Most reported values range from 47% to 57% RUP although we obtained somewhat higher values (Brouk et al., 1994b). One often assumes that wet CDG has lower concentrations of RUP than does dried CDG, but the differences are slight. Firkins et al. (1984) reported 47% RUP for wet CDG and 54% RUP for the dried product, which probably represents a realistic difference in RUP for the wet versus the dried products. Most of the readily degradable proteins in corn have been degraded during the fermentation process, so the protein remaining in the CDG is going to be proportionately higher in RUP than in the original corn. However, if RUP values for dried CDG are quite high (e.g. > 80% of CP), it may be advisable to also check for heat damaged, undigestible protein.

The quality of protein in CDG is fairly good. As with most corn products, lysine is the first limiting amino acid in CDG for lactating cows. More will be said about protein quality below in discussions about production responses to CDG.

Production Response When Fed Corn Distillers Grains

Table 1 summarizes milk production from several experiments in which cows were fed CDG. In experiments that compared CDG to soybean meal as the protein supplement, production was similar (Schingoethe et al., 1983; 1999) when fed wet CDG or higher (Nichols et al., 1998) when fed dried CDG than when fed soybean meal. With DDGS, production was similar to with soybean meal in a Nebraska study (Owen and Larson, 1991) and in a Florida study (Powers et al., 1995) in which the DDGS was dark and possibly heat damaged. When fed lighter colored DDGS from whiskey or from fuel-ethanol preparations, production was higher ($P < 0.05$) than when fed soybean meal (Powers et al., 1995).

Several experiments evaluated the protein quality of CDG and how additional protein or amino acid supplementation can be used to improve productivity of lactating cows. In the trial by Nichols et al. (1998), production increased when cows were fed ruminally protected lysine and methionine (RPLM). Wisconsin researchers (L. Armentano et al., 1997, unpublished results) observed similar increases with lysine supplementation. This response was expected because the protein in diets based on corn products are typically limiting in lysine. The greater production with CDG-based diets than with soybean-based diets was impressive but not entirely expected based on previous research with other corn-based products such as corn gluten meal. A multi-university study by Polan et al. (1991) observed lower production when fed corn gluten meal in place of soybean meal, even when the corn gluten meal was supplemented with RPLM.

However, when one has obtained good results in an experiment, one shouldn't repeat it. The next step in our efforts to improve the quality of protein in diets of cows was to compare CDG as the only protein supplement to a blend of proteins that included CDG (Liu et al., 2000); both diets were fed with or without RPLM. The supplemental proteins fed in the BLEND diet were 25% from CDG, 25% from fish meal, and 50% from soybean meal. Theoretical evaluations of these diets (Schingoethe, 1996; O'Connor et al., 1993) indicated that the BLEND diet contained a more desirable array of amino acids and should have supported greater production than the CDG diet. However, this time there was no additional production when the

CDG diet was supplemented with RPLM. Also, production was not significantly higher when fed a blend of several high quality protein supplements instead of CDG as the only protein supplement.

The above studies illustrate that CDG is a good quality protein source and that it cannot be easily improved upon. Corn distillers grains can be easily used as the only source of supplemental protein in many dietary situations.

Energy in Corn Distillers Grains

Some speculated that the CDG available today may contain more energy than indicated by the "book" values. Therefore, we (Brouk et al., 1994a) conducted an experiment to determine the energy value of wet CDG for lactating cows. The research indicated that the digestible energy (DE), metabolizable energy (ME), and NE_L of wet CDG were 1.81, 1.63, and 1.00 Mcal/lb DM, respectively. These values are 7 to 11% higher then previously published values (NRC, 1989). The NE_L values (0.85 to 0.89 Mcal/lb) calculated via methods used in the newer dairy NRC (2001) would likely be proportionately lowered for all feeds but would still indicate more NE_L for CDG than the older values.

Wet versus Dried Distillers Grains

One of the objectives of this presentation is to provide information about DDGS, but so far the presentation has contained information almost interchangeably about both wet and dried distillers grains. That is because the nutrient content of the dry matter is essentially the same for both wet and dried CDG, except for possibly slightly lower RUP values for wet than for dried CDG (Firkins et al., 1984). I am not aware of any trials with lactating cows that directly compared wet versus dried CDG. The minimal amount of data comparing wet versus dried CDG with beef cattle would indicate that animal performance when fed wet CDG is just as good as or slightly better than when fed dried CDG. Likewise, I am not aware of direct comparisons between distillers grains versus distillers grains plus solubles. Again, I would expect similar animal performance with both products.

The main considerations between the use of wet versus dried CDG are handling and costs. Dried products can be stored for extended periods of time, can be shipped greater distances more economically and conveniently than wet CDG, and can be easily blended with other dietary ingredients. However, feeding wet CDG avoids the costs of drying the product. Some have indicated difficulty in pelleting mixes that contained substantial amounts of DDGS.

There are several factors to consider when feeding wet CDG that are not concerns when feeding DDGS. First, the product will not remain fresh and palatable for extended periods of time; 5 to 7 days is the norm. This storage time span will vary somewhat with environmental temperature. Products will spoil and become unpalatable more rapidly in hot weather, but may be kept in an acceptable form as long as 3 weeks under cool conditions. In our experiments with wet CDG, which covered all seasons of the year, we obtained a fresh supply of product every 7 days. This was acceptable except for one occasion when we obtained a spoiled product that was quite unpalatable, especially to some cows. Surface molds occasionally occurred and those spoiled materials were not fed. Thus, there was usually some feed lost; a problem that wouldn't be a consideration with dried CDG, or DDGS. The addition of preservatives such as

propionic acid or other organic acids may extend the shelf life of wet CDG, but scientific journal publications that document such results are difficult to find. Research is currently being conducted at SDSU to extend preservation time of wet CDG by putting it in a silo bag (K.Tjardes and C. Wright, 2001, unpublished) or by blending wet CDG with soyhulls (K. Kalscheur and A. Garcia, 2001, unpublished).

How Much Distillers Grains Can be Fed?

I recommend that dairy producers feed up to a maximum of about 20% of ration dry matter as distillers grains. With typical feed intakes of lactating cows, this would be about 10 to 12 lb of dried CDG or 33 to 37 lb of wet CDG per cow daily. There are usually no palatability problems and one can usually formulate nutritionally balanced diets with up to that level of distillers grains in the diet. For instance, with diets containing 25% of the dry matter as corn silage, 25% as alfalfa hay, and 50% concentrate mix, the CDG can likely replace most – if not all – of the protein supplement such as soybean meal and a significant amount of the corn that would normally be in the grain mix. In diets that contain higher proportions of corn silage, even greater amounts of DDGS may be useable. However, the need for some other protein supplement, protein quality (e.g. lysine limitation), and P concentration may become factors to consider. In diets containing higher proportions of alfalfa, less DDGS may be needed to supply the protein required in the diet, and in fact the diet may not be able to utilize as much DDGS.

Some (Schingoethe et al., 1999) have fed as much as 30% or more of the ration dry matter as distillers grains but that high an amount is not recommended. Total dry matter intake may be decreased because the total ration may be too wet when using wet CDG. Total dry matter intake may decrease when the diet is less than 50% dry matter, especially when fermented feeds are included in the diet (NRC, 2001). Palatability may become a problem with that much wet or dried CDG in the diet. One is likely to feed excess protein with 30% CDG in the diet, unless forages are all or mostly corn silage and/or grass hay. And, if it is wet CDG that one is feeding with a high corn silage diet, the high water content of the diet will likely limit total dry matter intake.

There may be fewer off-feed problems when feeding distillers grains than when feeding corn, based on research with beef cattle. That is because, even though the distillers grains contains similar amounts of energy as corn, the energy in distillers grains is primarily as digestible fiber and fat; in corn most of the energy is as starch. Ruminal starch fermentation is more likely to result in acidosis, laminitis, and fatty liver.

Other Corn Products as Feeds

There are several other corn products such as corn gluten meal, corn gluten feed, and corn distillers solubles that can also be fed to dairy cattle. I won't spend a lot of time talking about corn gluten meal and corn gluten feed, except for a sentence or two about each, because they are not included in the major thrust of this presentation. Corn gluten meal is a high protein (60% CP) and high RUP (55% of CP) feed that is a very good protein supplement but is best fed in combination with other protein supplements (Polan et al., 1991). Corn gluten feed is a good overall feed that is medium in protein (25% of CP), low in RUP (25% of CP), a good energy source (NE_L = 0.86 Mcal/lb), and sometimes priced competitively with other feed sources.

Corn distillers solubles will be discussed more extensively because they are a part of the same process that produces CDG. Distillers solubles are often blended in with the distillers grains before drying to produce DDGS, but the solubles may be fed separately also. We (DaCruz et al., 1996) conducted one experiment with lactating cows in which condensed corn distillers solubles (CCDS) were fed at 0, 5, and 10% of total ration dry matter. The CCDS contained 28% dry matter and that dry matter contained 18% CP, 21.5% ether extract (fat), 12.5% minerals, and contained an approximately 0.91 Mcal NE/lb. Milk production (75.2, 78.3, and 78.9 lb/d for 0, 5, and 10% CCDS diets) increased when fed the CCDS. Milk fat percentages (3.54, 3.33, and 3.43) were slightly lower ($P < 0.05$) when fed CCDS while milk protein percentages (2.93, 2.97, 2.95) were unaffected by diets. The added energy from fat in the CCDS likely contributed to the increased milk production but may have also caused the observed slight milk fat depression. Dry matter intakes (54.7, 53.8, and 49.6 lb/d) were similar for control and CCDS diets, although intake tended ($P < 0.10$) to be lower when fed 10% rather than 5% CCDS. It was concluded that feeding CCDS at 5% of ration dry matter is effective and profitable for dairy producers. There was no additional advantage to feeding CCDS at 10% of ration dry matter.

Conclusions

Corn distillers grains is a good protein and energy feed to include in rations for dairy cattle. The nutrient content of the dry matter in CDG is essentially the same for both wet and dried CDG. The nutrient content is also similar whether or not the solubles are added to the distiller grains to make DDGS, with the exception of the higher P content with the solubles added.

References cited

Brouk, M. J., C. P. Birkelo, and D. J. Schingoethe. 1994a. Energy partitioning of diets containing wet corn distillers grains by dairy cattle. J. Dairy Sci. 77 (Suppl. 1):234 (Abstr.).

Brouk, M. J., D. J. Schingoethe, and C. P. Birkelo. 1994b. In situ degradability of wet and dry corn distiller grains. J. Dairy Sci. 77 (Suppl. 1):135 (Abstr.).

DaCruz, C. R., M. J. Brouk, and D. J. Schingoethe. 1996. Utilization of condensed corn distillers solubles in lactating dairy cow diets. Pages 95-97 in Proc. 1996 SD Dairy/Forage Conf., Brookings, SD.

Firkins, J. L., L. L. Berger, G. C. Fahey, Jr., and N. R. Merchen. 1984. Ruminal nitrogen degradability and escape of wet and dry distillers grains and wet and dry corn gluten feed. J. Dairy Sci. 67:1936-1944.

Liu, C., D. J. Schingoethe, and G. A. Stegeman. 2000. Corn distillers grains versus a blend of protein supplements with or without ruminally protected amino acids for lactating cows. J. Dairy Sci. 83:2075-2084.

Loosli, J. K., K. L. Turk, and F. B. Morrison. 1952. The value of distillers feeds for milk production. J. Dairy Sci. 35:868-873.

National Research Council. 1989. Nutrient Requirements of Dairy Cattle. 6th rev. ed. Natl. Acad. Sci., Washington, DC.

National Research Council. 2001. Nutrient Requirements of Dairy Cattle. 7th rev. ed. Natl. Acad. Sci., Washington, DC.

Nichols, J. R., D. J. Schingoethe, H. A. Maiga, M. J. Brouk, and M. S. Piepenbrink. 1998. Evaluation of corn distillers grains and ruminally protected lysine and methionine for lactating dairy cows. J. Dairy Sci. 81:482-491.

O'Connor, J. D., C. J. Sniffen, D. J. Fox, and W. Chalupa. 1993. A net carbohydrate and protein system for evaluating cattle diets. IV. Predicting amino acid adequacy. J. Anim. Sci. 71:1298-1311.

Owen, F. G., and L. L. Larson. 1991. Corn distillers dried grains versus soybean meal in lactation diets. J. Dairy Sci. 74:972-979.

Powers, W. J., H. H. Van Horn, B. Harris, Jr., and C. J. Wilcox. 1995. Effects of variable sources of distillers dried grains plus solubles or milk yield and composition. J. Dairy Sci. 78:388-396.

Polan, C. E., K. A. Cummins, C. J. Sniffen, T. V. Muscato, J. L. Vincini, B. A. Crooker, J. H. Clark, D. G. Johnson, D. E. Otterby, B. Guillaume, L. D. Muller, G. A. Varga, R. A. Murray, and S. B. Pierce-Sandner. 1991. Responses of dairy cows to supplemental rumen-protected forms of methionine and lysine. J. Dairy Sci. 74:2997-3013.

Schingoethe, D. J. 1996. Balancing amino acid needs of the dairy cow. Anim. Feed Sci. Technol. 60:153-160.

Schingoethe, D. J., M. J. Brouk, and C. P. Birkelo. 1999. Milk production and composition from cows fed wet corn distillers grains. J. Dairy Sci. 82:574-580.

Schingoethe, D. J., A. K. Clark, and H. H. Voelker. 1983. Wet corn distillers grains in lactating dairy cow rations. J. Dairy Sci. 66:345-349.

Table 1. Milk production response to diets containing corn distillers grains as the supplemental protein source.

	Protein supplement					
Experiment	SBM	SBM RPLM	CDG	CDG +RPLM[1]	BLEND	BLEND +RPLM
	(milk, lb/d)					
Schingoethe et al., 1983	59.5	---	60.8[3]	---	---	---
Schingoethe et al., 1999	67.7	---	67.9[3]	---	---	---
Nichols et al., 1998	75.6	75.0	77.8[4]	80.9[3]	---	---
Liu et al., 2000	---	---	71.9[4]	69.9	72.3	72.3
Owen & Larson, 1991	74.5	---	75.6[5]	---	---	---
Powers et al., 1995	59.1	---	61.1[6*]	---	---	---
Powers et al., 1995	59.1	---	61.3[7*]	---	---	---
Powers et al., 1995	59.1	---	59.3[8]	---	---	---

[1]RPLM: ruminally protected lysine and methionine
[2]BLEND: supplemental protein was approximately 25% from CDG, 25% from fish meal, and 50% from soybean meal (SBM).
[3]Wet CDG
[4]Dried CDG
[5]Dried CDG plus solubles
[6]Whiskey dried CDG plus solubles
[7]Fuel-ethanol dried CDG plus solubles
[8]Darker fuel-ethanol dried CDG plus solubles
[*]Production was greater than with SBM, $P < 0.05$