Can We Feed More Distillers Grains?

David J. Schingoethe[1]
Dairy Science Department
South Dakota State University

Abstract

Distillers grains is a very good protein source (>30% crude protein) which is high in ruminally undegradable protein and is very good energy source (NE_L ~1.02 Mcal/lb of dry matter; **[DM]**) for lactating cows and growing cattle. The modest fat concentration (10 to 12% of DM) and the readily digestible fiber (39% neutral detergent fiber; **NDF**) contribute to the high energy in distillers grains. The current large supply and competitive prices for distillers grains make it economically attractive to feed as much as possible. One can easily formulate nutritionally balanced diets for lactating cows that contain approximately 20% of the ration DM as distillers grains, an amount that is more than the conservative amounts that some people recommend, but less than the 30 to 40% that has been fed in some dairy studies or the 40 to 50% that has been included in diets of finishing cattle. This presentation summarizes the results of feeding distillers grains, especially larger amounts, to dairy cattle, points out where the maximums may occur, and points to possible differences to consider when feeding wet versus dried distillers grains.

Introduction

Distillers grains have been fed for more than 100 years; however, it is just during recent times that large quantities are becoming available and at competitive prices. Also, the products available today usually contain more protein and energy (Birkelo et al., 2004) than older "book values", even more than listed in the recent dairy NRC (2001), and can be of uniformly good quality. This reflects the improved fermentation efficiency of the new generation ethanol plants (Spiehs et al., 2002).

For several years, I as well as others have recommended that one can feed 20% of the ration DM as distillers grains. This may be considered as a sizable amount; approximately 10 to 13 lb/head/day of dried or 30 to 40 lb/day of wet distillers grains, but an amount that can be easily fed in nutritionally balanced diets and with very good animal performance. This recommendation is based on research by others and us, some of which will be reviewed in this presentation. Research will also be reviewed in which greater amounts of distillers grains were fed, pointing out some limitations but also indicating that the "20% of DM figure" may actually be conservative.

Virtually all of the distillers grains available today is distillers grains with solubles **(DGS)** because, while the solubles can be fed separately, they are usually blended back with the distillers grains. In fact, many research studies don't designate whether the product used was with or without solubles. The composition of corn distillers grains is essentially the same with or without solubles added, except for a lower phosphorus content (~0.4%) without solubles because the solubles are quite high (~1.35%) in phosphorus. The protein content may be slightly lower and the fat content slightly higher

[1]Contact at: 303B Dairy-Microbiology Bldg., Box 2104, Brookings, SD 57007-0647, (605) 688-5483, FAX: (605) 688-6276, Email: david.schingoethe@sdstate.edu

with solubles, reflecting the slightly lower protein and higher fat content of the solubles. If a DGS product contains substantially more fat (e.g. > 15%) and/or phosphorus (e.g. >1.0%), it is very likely that more than normal amounts of distillers solubles were blended with the distillers grains, or that the processor had problems with separation of materials during the handling of solubles. Such variations also point out the importance of obtaining analytical data on the specific product being received from a supplier and the importance of suppliers providing uniform, standardized products.

This presentation will discuss primarily the research with feeding DGS, both wet and dried, and especially look at the feeding of large amounts of DGS. Other distillers coproducts, such as condensed corn distillers solubles **(CCDS),** will be mentioned only briefly. In the future, there will likely be a host of new and improved products. For instance, improvements in fermentation technology already provide DDGS today that contain more protein and energy than DGS of previous years. It is also becoming feasible to “fractionate” in some manner DGS into products that are higher in protein, other products that are higher in fat or in fiber, and products that are higher or lower in phosphorus (Rausch and Belyea, 2006). And some products from ethanol production may find their way into non-food uses.

Production Response to Distillers Grains

More than two-dozen research trials have been conducted since 1982 in which distillers grains, either wet or dried, were fed to lactating cows. Amounts fed ranged from 4.2% of total dietary DM (Broderick et al., 1990) to 41.6% of DM (Van Horn et al., 1985). Kalscheur (2005) conducted a meta analysis of 24 studies reported from 1982 to 2005, involving 98 treatment comparisons. An abbreviated summary of this extensive survey of virtually all of the modern research data available about feeding DGS to lactating cows is listed in Table 1.

Distillers grains are palatable and readily consumed whether wet or dried; however, some decreases in DM intake can occur when cows are fed high amounts of DGS, especially wet DGS. Dry matter intakes were as high as or higher than intakes of control diets even with more than 20% DGS in the diet (Table 1). While DM intakes were not affected by inclusion of even high amounts of dried DGS (Kalscheur et al., 2004b; Kalscheur, 2005), DM intakes with wet DGS diets (46.1, 52.2, 50.5, 47.0, and 41.0 lb/day, respectively, for 0, <10, 10 to 20, 20 to 30, and >30% wet DGS) tended to decrease with more than 20% of the DM as wet DGS and significantly decreased ($P < 0.05$) with more than 30% of DM as wet DGS. Gut fill may limit DM intake when diets contain less than 50% DM, which is likely to occur when diets contain more than 20% of DM as wet DGS in diets that already contain other moist feeds, such as corn silage or haylage. Indeed, Hippen et al. (2003) observed decreased DM intake with a corresponding decrease in milk production when wet DGS supplied more than 20% of the dietary DM in diets that contained only 40 to 46% DM. Schingoethe et al. (1999) also observed decreased DM intake when diets contained 31% of DM as wet DGS in a 47% DM diet, but milk production was similar to the control diet.

Milk production was usually similar to production with control diets, and in many cases, higher when fed any amount of DGS (Table 1). With dried DGS, production tended to be highest for diets containing up to 30% DGS, while with wet DGS, production was highest when fed up to 20% DGS (Kalscheur, 2005). To illustrate this point, Kleinschmit et al. (2006b) used a standard, good quality dried DGS to evaluate the response to 2 specially processed dried DGS products intended to have even better quality. Milk production was higher for all 3 dried DGS products than for soybean meal-based control diet, with only small additional differences in response due to the improved dried DGS quality. Florida research (Powers et al., 1995) indicated higher production when dried DGS were fed from either whiskey or fuel ethanol plants than when soybean meal was fed. However, to point out the importance of protein quality when a dried DGS product was darker and possibly heat damaged, milk production was lower than when fed the lighter, golden colored dried DGS but still similar to production achieved when soybean meal was fed (Powers et al., 1995).

Most distillers grains in the U.S. today is made from corn and the quality of protein in corn DGS is fairly good. As with most corn products, lysine is the first limiting amino acid in corn DGS for lactating cows, but corn DGS is a very good source of methionine. Therefore, sometimes (Nichols et al., 1998), but not always (Liu et al., 2000), milk production increased when fed supplemental ruminally protected lysine and methionine with dried DGS, or when the dried DGS was blended with other protein supplements that contained more lysine. Kleinschmit et al. (2006b) showed that, while there may be differences in protein quality of various sources of dried DGS present today (Kleinschmit et al., 2006a), differences in yields of milk and milk protein may be slight, unless a product is greatly heat-damaged. In all 3 of the above referenced lactation studies, dried DGS supplied 20% of the dietary DM.

Feed efficiency, as measured by fat-corrected or energy-corrected milk yield per pound of DM intake, when cows were fed DGS is the same as or higher than when cows were fed a control diet. Research with beef cattle (Larson et al., 1993; Ham et al., 1994) often showed increased feed efficiency when fed distillers grains products in place of corn. They concluded that this may in part be due to fewer off-feed problems and reduced subacute acidosis. Similar results were observed when feeding wet corn gluten feed (Krehbiel et al., 1995), another byproduct feed that also contains high amounts of digestible fiber. That is because, even though the DGS contains similar amounts or more energy than corn, the energy in DGS is primarily in the form of digestible fiber and fat; in corn, most of the energy is in the form of starch. Ruminal starch fermentation is more likely to result in acidosis, laminitis, and fatty liver. Most studies with dairy cattle have been short-term studies, which may not allow for detection of such responses. A continuous trial with lactating cows is currently in progress at SDSU (Hippen et al., unpublished results) in which lactating cows are being fed 15% of dietary DM as wet DGS for the entire lactation, during the dry period, and the first 70 days of the next lactation. An intent is to also evaluate any possible health issues that may occur with long-term feeding of DGS. Results from the first year of this study (Mpapho et al., 2006) indicate similar milk production, milk composition, feed intake, and reproductive efficiency with wet DGS as with the control diet.

Wet Versus Dried DGS

Very few trials compared wet versus dried DGS; most trials simply compared DGS to a control diet. The meta analysis (Kalscheur, 2005) indicated similar DM intake, milk yield, and milk composition when cows were fed wet or dried DGS; however, most of those experiments cited had no direct comparison between wet and dried DGS. When Al-Suwaiegh et al. (2002) directly compared 15% of DM as wet versus dried corn or sorghum DGS for lactating cows, they observed similar production for both wet and dried DGS but 6% more milk ($P < 0.13$) with corn versus sorghum DGS. There was no control, non-DGS diet fed in that experiment. Research by Anderson et al. (2006) observed greater production when cows were fed either wet or dried DGS, each fed at 10 and 20% of dietary DM, than when cows were fed the control diet. They observed a tendency ($P = 0.13$) for greater production when cows were fed wet DGS instead of dried DGS, and a tendency ($P = 0.12$) for greater production when cows were fed 20% of the ration DM as DGS versus 10%, either wet or dried.

Digestibilities of wet and dried DGS are usually considered to be similar; however, few studies have actually compared the digestibilities of wet and dried DGS. Lodge et al. (1997) determined that corn wet DGS was more digestible than was sorghum wet DGS, and wet DGS products were more digestible than dried DGS. Firkins et al. (1984) observed similar ruminal digestibility with wet and dried DGS but higher ruminally degradable protein in the wet product.

The main considerations regarding the use of wet versus dried DGS 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 DGS, and can be easily blended with other dietary ingredients. Feeding wet DGS avoids the costs of drying the product, but there are other factors to consider when feeding wet DGS that are not concerns when feeding dried DGS. Wet DGS 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 as 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. Surface molds occasionally occur, thus there is usually some feed lost; a problem that wouldn't be a consideration with dried DGS. The addition of preservatives such as propionic acid or other organic acids may extend the shelf life of wet DGS (Spangler et al., 2005), but refereed journal publications that document such results are limited. We at SDSU (Kalscheur et al., 2002; 2003; 2004ab) successfully stored wet DGS for more than 6 months in silo bags. The wet DGS was stored alone or blended with soyhulls (Kalscheur et al., 2002), with corn silage (Kalscheur et al., 2003), and with beet pulp (Kalscheur et al., 2004a). Some field reports indicate successful preservation of wet DGS for more than a year in silo bags.

Milk Composition

The composition of milk is usually not affected by feeding DGS unless routinely recommended ration formulation guidelines, such as feeding sufficient amounts of forage fiber, are not followed. Some field reports indicated milk fat depression when diets contained more than 10% of ration DM as wet DGS (Hutjens, 2004); however, those observations are not supported by research results. The data summarized in Table 1 from the meta analysis of 24 studies (Kalscheur, 2005) showed that there were no decreases in milk fat percentage when diets contained wet or dried DGS at any level, even as high as 40% of DM intake. The only time when milk fat percentage may have been lower with DGS was when diets contained less than 50% forage (3.21% fat versus 3.50 and 3.45% with 50% and >50% forage, respectively (Kalscheur, 2005). This result hints at why field observations of milk fat depression may have occurred. Because DGS contains an abundance of NDF, one is often tempted to decrease the amounts of forage fed when formulations indicate more than sufficient amounts of NDF are present in the diet. However, the small particle size of DGS means that its "effective fiber" is not as great as that of the forage fiber it replaced.

A recent study at SDSU supports the observations from the meta analysis. Cyriac et al. (2005) observed a linear decrease in milk fat concentration when cows were fed 0, 7, 14, and 21% of DM as dried DGS in place of corn silage, although milk production remained unchanged and milk protein percentage increased. The control diet contained 40% corn silage, 15% alfalfa hay, and 45% concentrate mix. When cows were fed low forage diets (45% of DM) that already caused a modest milk fat depression (3.38% fat), the feeding of increasing amounts of dried DGS resulted in a modest additional drop in milk fat percentage to 3.24% fat with 15% DGS (Leonardi et al., 2005). This slight response was less drastic than the response observed by Cyriac et al. (2005). Thus, nonforage fiber sources of NDF, such as in DGS, can partially replace forages at times when forage supplies may be limited; however, one must realize that some milk fat depression may occur under these conditions.

Some have surmised that there is a lot of "free oil" in DGS that may be more likely than "bound fat" to interfere with ruminal fermentation and cause milk fat depression. However, any free oil in DGS is most likely in the solubles, which may account for 15 to 30% of the fat in DGS. If that is the case, feeding CCDS should cause a milk fat depression. When we fed 5 or 10% CCDS, we observed only a slight decrease in milk fat tests, going from 3.54 to 3.38% fat (DaCruz et al., 2005). In a recently completed experiment (Sasikala-Appukuttan et al., 2006), feeding 10 or 20% CCDS (2 and 4% added dietary fat) caused no milk fat depression, although milk fat tests tended to be low with all diets, including the control, in that experiment.

The fatty acid content of milk fat when cows are fed DGS is not expected to be affected greatly but has been evaluated in a couple of studies. Because the fat in DGS is quite unsaturated with typically more than 60% linoleic acid, it is logical to expect a modest increase in the concentration of unsaturated fatty acids in the milk produced as observed by Schingoethe et al. (1999). Leonardi et al. (2005) and Anderson et al. (2006) also reported modest increases in the healthful fatty acid cis-9,trans-11 conjugated linoleic acid **(CLA)** and its precursor vaccenic acid (trans-11 C18:1) in milk. They observed little or no change in the fatty acids that may be related to milk fat depression, trans-10 C18:1 and trans-10. cis-12 CLA.

Milk protein content is seldom affected by feeding DGS unless protein is limiting in the diet. Then the lysine limitation in DGS may cause a slight decrease in milk protein percentage (Kleinschmit et al., 2006b). This effect may be more noticeable in diets that contain more than 30% DGS (Kalscheur, 2005) because DGS is high in ruminally undegradable protein and limiting in lysine (Kleinschmit et al., 2006a). Milk protein percentage is typically decreased about 0.1% when cows are fed added fat from any source, so that can be a minor consideration when feeding DGS; however, most studies with DGS showed no effect on milk protein percentage.

Summary and Recommendations

One can easily formulate nutritionally balanced diets for lactating cows that contain approximately 20% of the ration DM as distillers grains. Optimal feed intake and productivity often occurs with 20% or more DGS in the diet. In diets that contain higher proportions of corn silage, even greater amounts of sGS may be usable without feeding excessive amounts of protein. However, the need for some other protein supplement, protein quality (e.g. lysine limitation), and phosphorus concentration may become factors to consider. In diets that contain higher proportions of alfalfa, less than 20% DGS may be needed to supply the protein required in the diet, thus the diet may not be able to utilize as much DGS without feeding excess protein. When feeding more than 20% distillers grains, one is likely to feed excess protein, unless forages are all or mostly corn silage and/or grass hay, and feeding excess phosphorus may become a consideration. Wet DGS can be well utilized up to 20% of dietary DM; however, if the diet also contains other moist feeds, such as corn silage or haylage, gut fill may limit total DM intake and production with diets that contain more than 20% of DM as wet DGS. Decreased DM intake is likely with more than 30% of DM as wet DGS. Milk fat depression is not a problem with the feeding of any amount of DGS unless the diet does not contain adequate amounts of forage fiber.

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Table 1. Dry matter intake (DMI), milk yield, and milk fat and protein percentages from cows fed diets containing wet or dried distillers grains with solubles.[1]

Inclusion level	DMI	Milk	Fat	Protein
(% of DM)	(lb/day)		(%)	
0	48.9[b]	72.8[ab]	3.39	2.95[a]
4 to 10	52.2[a]	73.6[a]	3.43	2.96[a]
10 to 20	51.6[ab]	73.2[ab]	3.41	2.94[a]
20 to 30	50.3[ab]	73.9[a]	3.33	2.97[a]
> 30	46.1[c]	71.0[b]	3.47	2.82[b]
SEM	1.8	3.0	0.08	0.06

[a,b,c]Values within a column followed by a different superscript differ ($P < 0.05$).

[1]Adapted from Kalscheur (2005).