Feedstuffs Reprint

Distillers grain protein quality for ruminants

How can nutritionists manage variability to optimize animal performance when including DDGS in diet formulations?

By **KEVIN HERRICK** and **FERNANDO DIAZ-ROYON***

IN 1996, U.S. distillers grain production was about 1.0 million metric tons. In 2016, it is estimated that U.S. distillers grain production will be more than 40 mmt. This is a 39 mmt increase over a 20-year period. As a comparison, U.S. soybean meal production increased by only 9 mmt over this same period.

With the volume and growth rate of distillers grain production, it comes as little surprise that we are discussing distillers grain nutrition. However, what may be surprising is how much variability there actually is in distillers grains and how this may be affecting livestock diet formulation.

Source of variability

Although the general process for ethanol production is the same in that yeasts ferment starch from feedstocks to produce ethanol, the exact process is complicated and involves many variables. Factors such as facilities, management and overall business objectives are unique for each biorefinery, and as a result, co-product production and quality tend to vary.

Furthermore, since the only components removed from the grain during the fermentation process are the starch and soluble carbohydrate components, variability in the grain source ultimately causes additional variability in distillers grains.

Protein

One concern for livestock nutritionists when feeding distillers grains is the quality of protein and, specifically, the effect the drying process has on protein digestibility. As a result, numerous research projects have been conducted with poultry and swine models to investigate the effect of drying on protein and amino acid quality.

Data from that research can be used to estimate protein variability in the monogastric model; however, those data may not be applicable to the ruminant model. The amount of protein that escapes ruminal degradation, as well as the amount digested in the intestines, is required to correctly determine the value in a ruminant animal.

A few studies have investigated distillers grain protein quality for the ruminant animal. Using ruminally cannulated dairy cows, South Dakota State University researchers (Kleinschmit et al., 2007) evaluated several sources of dried distillers grains with solubles (DDGS) for their ruminal and intestinal disappearance characteristics (Table 1).

The amount of protein, as a percentage of total crude protein (CP) that escaped the rumen, ranged from 59.10% to 71.70% among the five DDGS sources. Of the protein that escaped the rumen, between 59.20% and 76.80% was estimated to be digested in the intestines. When the amount of protein that escapes the rumen is multiplied by the intestinal protein digestibility, the result is an estimate of the amount of protein intestinally digested in the ruminant — intestinally absorbable dietary protein (IADP). Similarly, the total amount of protein digested in the rumen and intestines — total digestible protein (TDP) — can be estimated by summing the ruminally degraded protein and IADP.

As expected, those DDGS sources with high ruminal degradability also had high intestinal degradability. As a result, IADP had a smaller range of values than ruminally undegradable protein (RUP) or intestinally digestible protein (IDP): 41.10-49.00% for IADP versus 60.30-71.17% for RUP and 59.20-76.80% for IDP.

The Kleinschmit et al. (2007) work was completed when the ethanol industry was just beginning to rapidly expand. This was a period in which biorefineries were still learning about ethanol fermentation, and as a result, there was a tremendous amount of variability in co-product quality. It can be argued that many biorefineries have evolved in the past 10 years to become more aware of

1. CP degradation parameters of five sources of DDGS after ruminal incubation*

Item	DDGS1	DDGS2	DDGS3	DDGS4	DDGS5	Avg.	Std. dev.
RUP	71.70	63.70	59.10	67.50	60.30	64.46	5.20
IDP	59.20	76.80	74.20	63.00	68.10	68.26	7.38
IADP	42.40	49.00	44.00	42.40	41.10	45.78	3.09
TDP	70.70	85.30	84.90	74.90	80.80	79.32	6.38

*Data from Kleinschmit et al., 2007.

2. CP degradation parameters of nine sources of DDGS after *in vitro* digestion*

Item	DDGS1	DDGS2	DDGS3	DDGS4	DDGS5	DDGS6	DDGS7	DDGS8	DDGS9	Avg.	Std. dev.
RUP	65.03	68.19	68.42	65.07	66.28	62.80	61.86	63.17	62.85	64.85	2.40
IDP	78.64	77.91	75.84	77.52	76.19	80.24	82.86	80.07	84.23	79.28	2.86
IADP	51.14	53.13	51.89	50.44	50.50	50.39	51.26	50.58	52.94	51.36	1.07
TDP	86.11	84.94	83.47	85.37	84.22	87.49	89.40	87.41	90.09	86.50	2.27

*Samples sent to commercial laboratory and analyzed using Ross *in vitro* method.

3. CP degradation parameters of DDGS, as estimated by three different sources

Item	Kleinschmit et al., 2007	Current evaluation	NRC, 2001	Avg.	Std. dev.
RUP	64.46	64.85	50.80	60.04	8.00
IDP	68.26	79.28	80.00	75.85	6.58
IADP	45.78	51.36	37.20	44.78	7.13
TDP	79.32	86.50	90.70	85.51	5.75

*Dr. Kevin Herrick is technical service director of nutrition at Poet Nutrition. Dr. Fernando Diaz-Royon is a dairy nutrition and management consultant at GPS Dairy Consulting LLC in Brookings, S.D.

processes that may negatively affect co-product quality. As a result, the distillers grains produced today may be significantly different from distillers grains produced five or 10 years ago.

To demonstrate these differences, we recently submitted nine samples of DDGS to a commercial laboratory to be analyzed for ruminal and intestinal degradability using the Ross method (Table 2). The Ross method is a laboratory technique developed at Cornell University using an *in vitro* procedure incubated at 16 hours and corrected for microbial contamination. The samples of DDGS were collected directly from nine different ethanol biorefineries located in South Dakota, Iowa, Nebraska and Ohio.

Interestingly, the RUP values for this set of DDGS (64.85% of CP) were very similar to the DDGS used in the Kleinschmit et al. (2007) research (64.46% of CP). However, what was different between the two groups of DDGS samples was the intestinal digestibility. The Kleinschmit et al. samples averaged 68.26% of CP, while the samples in the more recent evaluation averaged more than 10 percentage points greater, with a value of 79.28% of CP. This resulted in IADP increasing from 45.78% of CP for the previous study to 51.36% of CP in the current evaluation. Finally, the standard deviations for all measures were all less for the current samples than the previous samples.

Implications

We recognize that we should be cautious when comparing RUP and IDP using different methods. However, this exercise does raise some questions nutritionists should ask when including distillers grains in their formulations: What values are preloaded in the formulation software? Are values for protein digestibility being considered when switching distillers grain sources?

To illustrate this point, we can look at the variability observed among the Kleinschmit et al. (2007) research, the National Research Council (NRC) 2001 values and the DDGS samples submitted in our set (Table 3).

The 2001 NRC estimated the RUP of DDGS to be 42.2% of CP when dry matter intake was 2% of bodyweight and 50.8% of CP for 4% of bodyweight. These values are much less than the other comparisons we've discussed. However, IDP estimated in the 2001 NRC (80.0% of RUP) is very similar to the estimates determined in the current evaluation (79.28% of RUP) and much greater than the Kleinschmit et al. (2007) research (68.26% of RUP). As a result, we see significant differences in estimates of IADP among these three sources.

What can nutritionists do?

It is very easy to demonstrate differences among DDGS sources, and we think most nutritionists will recognize why variability occurs. However, how can nutritionists manage this variability to optimize animal performance when including DDGS in diet formulations?

One approach is to take advantage of recent advances in methods to determine feed quality. Several commercial laboratories have started offering tests for both protein and fiber digestibility determined with *in vitro* methods. Although the *in vitro* method is still only an estimate of digestibility, it does provide a better starting point when entering values into ration software.

Another approach is to engage either the DDGS suppliers or the ethanol biorefineries to provide more information about their product. In many cases, these individuals may have data from samples they have submitted to commercial laboratories or other research to provide estimates of protein digestibility.

In conclusion, DDGS offers an economical source of protein and energy that can be effectively used in diet formulations. The large supply of DDGS as well as the differences among ethanol biorefineries have created co-products with a lot of variability. In order to effectively use DDGS in diet formulations, nutritionists need to recognize these differences and adjust accordingly. Fortunately, advances in feed evaluation methods have made this information easier to determine.

References

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