UPDATE ON CORN DISTILLERS CO-PRODUCTS IN RUMINANT DIETS

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INTRODUCTION

The ethanol industry is changing in ways that will have a profound impact on livestock production. The industry is changing in scope, business/ownership structure, objectives, and processes. For the livestock industry it means changes in corn supply, quantity and distribution of co-products, and even the kinds of co-products available. The evaluation underway is of a magnitude and pace that within five years this essay may be of little value beyond historical perspective.

My charge is to characterize new ethanol production co-products. There are limits to the depth of nutritional assessment obtainable at this time because the products are so new and actually still evolving. As such, the focus can only be on general characteristics and estimates of compositional profile and some perspective of how ethanol production co-products have and will continue to evolve.

MILLING PROCESSES

The most pervasive change in the last 10 years is the growth of dry milling plants and the shift from high fructose corn syrup to ethanol production in some wet milling plants. The stark contrast of dried distillers grains + solubles (DDGS) and dry corn gluten feed (DCGF) continue to be misunderstood, in spite of the publicity related to biofuels and the tonnage of co-products being used in livestock diets. It is disconcerting that it is still common to hear persons involved in the industry use these terms interchangeably.

The terms DCGF and DDGS have not changed in decades, but even these "traditional" co-products should be considered as new feeds. Table 1 shows the compositional aspects of these feeds as depicted in the 1996 NRC Nutrient Requirements for Beef Cattle as well as recent analytical summaries of current production from commercial entities. These feeds are remarkably different from reference values in several aspects, but the differences are not uniform across sources. The prevalent, long standing dogma that DCGF has a high S content and that DDGS has a low S content clearly is outdated. Other minerals, as well as CP, fat, and NDF differ markedly in this compilation.

Among dry milling plants, milling is not created equally. The BPX process of Broin Industries, described in Feedstuffs (2005a) causes a visible change in particle size. The impact of this change on digestion kinetics or feed handling characteristics (especially in wet products) is not addressed by proximate analysis and merits careful study. There is no definitive change in feed grade co-product terminology associated with grain processing method beyond wet vs dry milling. The term DDGS applies to distillers grains produced regardless of the grain processing technology used.

NEW PRODUCTS

Another change in dry milling is the BFRAC™ technology brought forth by Broin Industries (Feedstuffs, 2005b). This involves separating the bran and germ from the starch prior to the starch entering the fermentor. By concentrating the starch going into the fermentor, this improves fermentor efficiency but also substantially alters the composition of the distillers grains produced. The CP content is elevated while NDF, fat, and P content are lowered (Dakota Gold HP, Table 1). The dietary role and nutritional compliment to this form of distillers grains will differ dramatically from that appropriate for more traditional DDGS. Using borate buffer and detergents fractionation, it appears that the ruminal escape CP characteristic is similar to that of traditional DDGS. Kleinhans, et al. (2006) estimated UIP at 41% of CP.

Table 1. Traditional and new co-products produced during ethanol production[a]

	CP	NDF	EE	P	S	K	Cu	Zn	Fe
Distillers Grains									
NRC	30.4	46.2	10.7	0.83	0.44	1.08	10.6	67.8	358
Comm 1	29.3	26.0	10.7	0.87	0.95	1.08	7	98	87
Comm 2	31.7	26.7	14.6	0.99	0.97	1.42	6	66	--
Gluten Feed									
NRC, 96	23.8	36.0	3.9	0.95	0.47	1.40	7	73	226
Comm 1	16.5	37.6	4.0	0.55	0.37	0.96	7	46	
Comm 2	19.35	44.7	2.7	0.66	0.46	1.02	5	60	74
Dakota Gold HP	46.8	20.4	3.3	0.40	0.87	0.34	5	87	57
Bran Cake 1	12.1	28.6	8.8	0.70	0.59	1.09	4	87	134
Bran Cake 2[b]	14.9	39.4	10.4	0.65	0.35	-	-	-	-
Germ 1[c]	12.6	24.3	47.7	0.35	0.18	0.16	3	35	46
Germ 2[d]	14.5	17.8	18.1	1.33	0.20	1.37	12	93	117
Germ 3[d]	16.8	24.5	19.2	1.50	0.19	1.53	10	98	100

[a] DM basis.
[b] from Bremer et al, 2006
[c] wet milling plant.
[d] dry milling plant.

The germ fraction generated by this process is not a comparable feed to the germ fraction produced during wet milling (Table 1). This new product is especially lower in ether extract (EE) than germ production from wet milling plants. Much of the phosphorous of corn is concentrated in this fraction, but that is manageable because the EE component should lower the grams P/kcal energy. The material is dry (>90% DM) and the meal form flows well, making it a very manageable fat source in ruminant diets. Little is known about feed value. In one finishing cattle experiment we observed that this new germ caused an increase ($P < 0.01$) in DMI (levels fed were 0, 10, 20, and 30% replacing corn). The higher inclusion levels resulted in poorer ($P < 0.05$) feed/gain (Table 2). This may have been caused by exceeding the digestive capacity for fat in the higher germ content diets. The steers fed the 30% germ diet would have consumed in excess of 750g EE/day.

Table 2. Diets and performance summary for steers fed corn germ[a]

	% Germ				
Treatment	0	10	20	30	
Diet[b]					
Oatlage, %	8.00	8.00	8.00	8.00	
Whole shelled corn, %	80.46	71.17	62.04	52.75	
SBM, %	7.29	6.58	5.71	5.00	
Supplement, %	4.25	4.25	4.25	4.25	
Germ, %	0	10.00	20.00	30.00	
Performance					SEM
Initial BW, kg	381	381	381	380	0.8
Final BW, kg	622	631	621	616	4.5
ADG, kg	1.72	1.79	1.71	1.69	0.029
DMI, kg	10.59[c]	11.11[d]	11.13[d]	11.21[d]	0.103
F/G	6.16[c]	6.26[c]	6.52[d]	6.66[d]	0.092

[a] 140 d study; 5 pens/diet; 8 steers/pen
[b] DM basis
[c,d] Means differ ($P < 0.05$).

Bran cake is the trade term used to describe the approximately 50/50 (As Is) compositing of corn bran derived in the BFRAC process and the condensed distillers solubles (CDS) separated from the low fiber, low fat fermentations that produce the higher protein DDGS. As expected, it is lower in CP (12%) than DDGS. The CDS inclusion elevates EE in this relatively higher fiber fraction (Table 1). The P and S content are also lower than in conventional distillers grains. This creates a niche product in that it would appear to be a more suitable composition to replace conventional DDGS in those situations where the DDGS was being included in diets at levels beyond that needed to meet dietary CP requirements. Bremer et al. (2006) reported that substituting bran cake for equal parts of dry rolled and high moisture corn caused linear improvements ($P < 0.01$) in ADG and Feed/Gain and a quadratic response ($P < 0.01$) in DMI. It appeared useful in these finishing diets at levels up to 45% of the diet (Table 3).

Table 3. Performance response to added bran cake[a]

	Level bran cake				P^b	
	0	15	30	45	Linear	Quadratic
Initial BW, kg	380	379	380	379	NS	NS
Final BW kg	577	591	596	604	0.01	NS
ADG kg	1.71	1.82	1.86	1.94	0.01	NS
DMI, kg	11.39	12.16	12.29	12.20	0.01	0.01
Feed/Gain	6.74	6.72	6.68	6.37	0.01	0.08

[a] Bremer et al., 2006.
[b] Probability; $P > 0.15$ = NS.

While not technically new, another change from the traditional options of wet distillers grains or DDGS is a co-product sometimes referred to as Modified Distillers Grains. In some newer plants, this product may still be referred to as wet distillers grains. These modified products are typically near 50% DM. This is achieved by several process derivations. Wet product may be partially dried to 50% DM; or wet distillers grains may be blended with DDGS; or CDS may be added to DDGS. These three options can produce three nutritionally different feeds, all under the common labels of Modified or Wet Distillers Grains (depending on the source). The modified material produced from milling systems that achieve greater particle size reductions could be described as somewhat of a paste. Producing an effective feed mix seems to be more challenging when using this product. This challenge is more pronounced when mixing diets with a substantial proportion of low bulk density component(s).

Changes in ethanol production co-products are ongoing. The advances in biodiesel production will add value to corn oil. We can anticipate seeing distillers grains that differ from the current product in that the oil has been removed. The net result will be that in de-oiled DDGS all other components (except energy) will become more concentrated proportional to the amount of oil removed. Germ may evolve into a de-oiled germ pulp causing a 20% concentration of all other components (except energy). Fiber hydrolysis may come on line within the next five years as well. The fiber substrate post-fermentation co-product may be high in crude protein and rogue pentoses and likely would have constituents such as de-oiled germ pulp added back along with CDS. If cellulose sources other than corn bran are used, lignin content of the co-product will become a primary effecter of feed value.

TAKE HOME

Ethanol co-products have and will continue to change. Nutritional values change even if the commodity name remains the same. It is imperative that you have assay sheets from the supplier to confirm the composition of the product(s) under consideration. Competitive bids for commodities from multiple sources becomes an increasingly complicated endeavor. These products represent economical feed inputs for cattle but the purchase does need to be fully aware of the products and how they are changing.

REFERENCES

Bremer, V. R., G. E. Erickson, T. J. Klopfenstein, M. L. Gibson, K. J. Vander Pol, and M. A. Greenquist. 2006. Evaluation of a low protein distillers by-product for finishing cattle. MP-88. Pages 57-59 in Univ. NE Beef Cattle Report., Lincoln.

Feedstuffs 2005a. Broin announces breakthrough in ethanol technology. In Feedstuffs Issue 10. Vol. 77.

Feedstuffs 2005b. Broin announces new ethanol process. In Feedstuffs Issue 36. Vol 77.

Kleinhans, G. B., R. H. Pritchard, and S. M. Holt. 2005. Composition and nutritive value of corn fractions and ethanol co-products resulting from a new dry milling process. BEEF 2005-12. Pages 54-58 in SD Beef Report, SDAES, Brookings.

NRC. 1996. Nutrient Requirements of Beef Cattle. 7th Rev. Ed. Natl. Academy Press, Washington DC.