

Co-product Feedstuffs of the Ethanol Industry & Beef Cattle

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Introduction

The ethanol industry is rapidly growing and producing a large quantity of feedstuffs for the ruminant animal as well as the monogastric species. The process in a nutshell involves the fermentation of carbohydrates from grains and other carbohydrate containing inputs (recent announcement of a plant in Canada that utilizes barley straw) for the production of ethanol, carbon dioxide, stillage, and mash.

Corn is approximately 2/3 starch, 7-10% crude protein, 2-4% fat, and for discussion about 0.25% phosphorus. For plants utilizing corn as the primary fermentation substrate, the process involves fermentation of the starch in the corn. This removal of the starch concentrates the remaining nutrients by approximately three fold resulting in a feedstuff that is high in fat, crude protein, minerals, and fiber (yes, corn has fiber). The mash co-products with the stillage/solubles added back is commonly referred as distillers grains plus solubles and may be either wet or dried. The wet co-product has a nutrient composition similar to that shown in Table 1.

Quality

The wet distiller's grain co-product has been shown to be superior to the dried product (Firkins et al., 1985; Ham et al. 1994 & 1995; Lodge et al. 1997). Lodge et al. (1997) observed wet distiller's grain co-product to have approximately 14% greater organic matter, 6% fiber, and 14.6% nitrogen digestibility compared to the same dried product (Figure 1). Due to the high dietary fat content of distiller's co-products, moderately high crude protein content, and ruminally degradable fiber, the energy value has been shown to be equal to or greater than that of corn. The actual energy value is variable as reported by Stock et al. (2000) in comparison to corn from "less current" studies (Table 2). Looking at the more recent research (1985-1999), Erickson and Klopfenstein (2003) report that the average improvement for efficiency of gain (unit of live weight gain per unit of dry matter intake) in comparison to corn may be near 124% across the varying inclusion rates studied with value being near 150% for inclusion rates between 12.6% and 28% of the diet dry matter.

Utilization in growing/backgrounding diets

Distiller's grains co-products have the flexibility to be utilized in a variety of production phases. Due to the low starch content of distiller's grains, they are well suited for high roughage diets and receiving rations. Supplementation for developing heifers or backgrounded cattle consuming a high roughage diet can make use of dried product easily. Loy et al. (2003) observed that utilization of dried distiller's grains-based supplement for heifers resulted in improved performance and efficiency in comparison to a dry rolled corn-based supplement. Research conducted at the University of Missouri (Table 3) illustrated that the utilization of dried distiller's grains for developing heifers resulted in improved cost of gain in comparison to more conventional feedstuffs (i.e. soybean meal and soybean hulls). Rate of supplementation offered in these research

studies varied, but calculated intake of dried distiller's grains approximately ranged between 1.0 lb/hd/d to 5.0 lb/hd/d.

Finishing rations

The majority of the research regarding utilization of ethanol industry co-products has focused on their use in the feedlot industry. Further, this research has investigated the responses to inclusion rate, wet vs. dried, and comparison to more conventional feedstuffs (i.e. soybean meal for protein and corn for energy). Some of the feedlot research responses for rations containing distiller's grains are summarized in Tables 4 through 6. Most notable is the depression in dry matter intake for higher inclusion rates of distiller's grains. This response is similar to the commonly observed reduction in dry matter intake with supplemental fat inclusion. Due to the higher energy content of fat in comparison to starch, the reduction in dry matter intake does not reduce performance but improves feed conversion as depicted in the data tables. Additionally, because distiller's grains contain approximately 65% ruminally undegradable protein (RUP), excess amino acids may be metabolized and used as an energy source. One notable concern with high dietary inclusion rates of distiller's grains, is the tendency for reducing the percentage of carcasses grading USDA Choice or greater. This phenomenon may be linked to reduced ruminal propionate production from the fermentation of dietary starch. Propionate is believed to be the primary energy substrate for intramuscular fat (marbling) deposition and may be reduced as corn or other starch containing ingredients are replaced with distiller's grains. This response, however, is not observed at low to moderate levels of inclusion.

Cost effectiveness

What should I pay for distiller's grains? This is often a "Frequently Asked Question". Often this question is more complex than a simple cost comparison of cents per unit of nutrient. For instance, what are the extra costs associated with handling and storage of the feedstuff in comparison to the current feedstuffs? What flexibility does feeding distiller's grains offer the grain farmer and cattle feeder with regards to marketing corn? If one wants to compare the value of a variety of feedstuffs, a program is available to assist you. Dr. Randy Shaver and Dr. Terry Howard developed a spreadsheet entitled "FEEDVAL" that can be utilized for comparing the value of several feedstuffs. It can be downloaded for free at <http://www.wisc.edu/dyisci/uwex/nutritn/spreadsheets/sprds.htm>. An example of this spreadsheet is shown below in Figure 2. Additionally, your consulting nutritionist likely has a least cost balancing software package that can shadow price or determine if the feedstuff is economically and nutritionally competitive to other feedstuffs currently being utilized. Several of your county extension agents also have this software. Additionally, simply comparing the cost of your current supplement to the value of distiller's grains is not an appropriate comparison. Remember that commercially available protein supplements often contain your macro- and micro-minerals, vitamins, ionophore and antibiotic. Utilizing distiller's grain co-products as a protein source may not eliminate your need for a supplement, rather it will change the supplement composition. One is encouraged to visit with their local nutritionist, feed representative, and/or extension agent for further discussion.

Phosphorus Concerns

As we briefly mentioned earlier and as depicted in Table 1, the phosphorus content of distiller's grains typically is three-fold greater than that of corn. The 1996 NRC Nutrient Requirements of Beef Cattle recommends that the dietary phosphorus level for a 900 pound finishing steer gaining 3.0 lb/d be 0.19% of the dietary dry matter or about 20 grams per day. Recent research by Erickson et al. (1999) would suggest that the dietary requirement of finishing steers is even lower than that reported by the NRC publication. The point is that the phosphorus needs of a finishing steer are likely to be exceeded for a conventional feedlot ration and no additional dietary phosphorus is required. Replacing corn with distiller's grains will result in increased dietary phosphorus content, intake, and excretion. Therefore, nutrient management plans should be altered when feeding distiller's grains to account for the additional dietary phosphorus content. Researchers at the University of Illinois and University of Missouri are investigating techniques to remove some of the phosphorus from the ethanol co-products as well as improve fermentation efficiency. Future changes in the fermentation technology are expected to come online and alter the co-product streams to allow for increased flexibility in product utilization.

Figure 1. Comparison of wet and dried distiller's grain by-product organic matter (OM), neutral detergent fiber (NDF), and true nitrogen (True N) as reported by Larson et al. 1997.

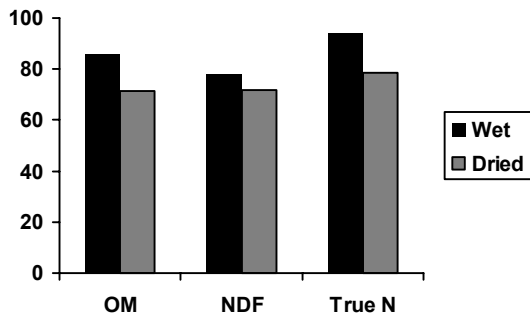


Table 1. Reported value for selected nutrients of wet distiller's grains plus solubles from one Wisconsin plant (values reported on a dry matter basis).

Dry matter, % ^a	33.67 – 34.81
Crude protein, % ^a	27.66 – 30.40
ADF Bound Protein, % ^b	3.52 – 8.69
Fat, % ^a	11.23 – 12.54
Calcium, % ^b	0.08 – 0.11
Phosphorus, % ^b	0.84 – 0.88
Calc. TDN, % ^b	72.52 – 74.10
OARDC Calc. TDN, % ^b	86.2 – 88.4

^a Range for three tests.

^b Range for two tests.

Table 2. Reported dietary inclusion rate and energy value for ethanol co-product in comparison to corn for past research as reported by Stock et al. (2000).

Reference	% of Diet DM	Energy, % corn
Rouse & Trenkle, 1980	15	116
Farlin, 1981	21.25	100
	42.5	124
	63.75	115
Hanke et al., 1982	14.6	94
Risk et al., 1982	10.5	83
	24.9	122
	43.6	110
Firkins et al., 1985	25	103
	50	122
Average		109

Table 3. Utilization of dried distiller's grains plus solubles for replacement heifers (Williams 2002).

Item	0.25 Soyhull	1DDGS	2DDGS	3DDGS
Start wt., lb	572	567	567	572
End wt., lb	604	623	650	652
ADG, lb/d	0.44c	0.79b	1.17a	1.12a,b
COG, \$/lb	\$1.33	\$0.53	\$0.44	\$0.42

Item	SBM	LoDDGS	HiDDGS
Start wt., lb	516	517	515
End wt., lb	822	815	847
ADG, lb/d	2.71	2.65	2.94
F/G, lb/lb	6.25	6.41	5.98
COG, \$/lb	0.281	0.268	0.254

Table 4. Performance responses to varying levels of wet distillers grains plus solubles for calf-fed and yearling finishing steers (Larson et al., 1993).

Item	0%	5.2%	12.6%	40%
<i>DMI, lb</i>	<i>18.5</i>	<i>19.2</i>	<i>18.6</i>	<i>17.4</i>
ADG, lb	2.9	3.1	3.1	3.2
F/G	6.5	6.3	6.1	5.6

Item	0%	5.2%	12.6%	40%
<i>DMI, lb</i>	<i>25.2</i>	<i>24.6</i>	<i>24.0</i>	<i>21.3</i>
ADG, lb	3.6	3.8	3.9	3.9
F/G	6.9	6.6	6.3	5.8

Table 5. Performance responses for finishing heifers fed varying levels of wet and dried distiller's grains plus solubles (Trenkle, 1996 & 1997).

	1.07% Urea	10% SBM	16% DDGS	16% WDGS	28% WDGS	40% WDGS
ADG, lb	3.41	3.58	3.72	3.80	3.64	3.59
DMI, lb	19.6	19.6	21.0	20.3	19.0	18.4
F/G	5.74	5.49	5.65	5.35	5.23	5.12

	1.07% Urea	20% WDG	40% WDG	40% WDG/DG
ADG, lb	3.03	3.36	2.94	3.06
DMI, lb	19.7	19.2	17.7	17.5
F/G	6.50	5.75	6.04	5.73
% Choice	35.0	29.2	16.7	0.0

Table 6. Response of finishing steers to a diet containing 30% dried distiller's grains plus solubles (DDGS) when compared to a diet predominately composed of dry rolled corn (DRC). (Fanning et al., 1999)

Item	DRC	30% DDGS
DMI, lb	23.5	22.9
ADG, lb	3.6	4.0
F/G	6.5	5.8
% Choice	95	70

Table 7. Quantity on an as-fed basis of wet distiller's (30% dry matter), modified distiller's (50% dry matter), and dried distiller's grains (90% dry matter) required for various classes of beef cattle to achieve an inclusion rate of 20% on a dry matter basis.

Type	Weight	WDG 30% DM	MDGS 50% DM	DDG 90% DM
Growing	500-700	10-12	5.5-7	3-3.5
Finishing	900-1200	15-20	9-12	4.5-6
Cow	1200-1500	16-20	9.5-12	5-7

South Dakota Extension Publication

Figure 2. Example of the FEEDVAL program.

Referee Feeds Used to Calculate Value of Nutrients

Item	Energy	Protein	Calcium	Phosphorus						
Feed:	Corn, Shelled	48% CP Soy Meal	Feed Limestone	Dicalcium Phosphate						
Cost \$	2.50 \$/Bu	260.0 \$/Ton	7.00 \$/cwt	27.00 \$/cwt						
Calc \$/cwt	\$4.46 \$/cwt	13.00 \$/cwt								
D.M., %	85.0	89.0	98.0	98.0						
C.P., %	10.0	53.9								
TDN, %	88.0	87.0								
Ca, %	0.02	0.28	36.00	18.00						
Phos., %	0.30	0.67		21.00						
Calculated Value of Nutrients, C.P., TDN, Ca & P										
Calcium, \$/lb ----->	\$0.191	Crude Protein, \$/lb--->	\$0.227							
Phosphorus, \$/lb -->	\$1.149	Energy, TDN \$/lb----->	\$0.333							
GRAIN- CONCENTRATES	D.M.	C.P.	TDN	Ca	Phos	Value \$/100 lb DM	Value \$ / 100 lb As Fed	Value \$/Ton As Fed		
	%	%	%	%	%			Feeding Loss %		
								0.0	3.0	6.0

Composition, % of Dry Matter

Alfalfa, 20% CP Dehy	93.0	21.5	62.0	1.43	0.29	\$6.99	\$6.50	\$130	\$126	\$122
Alfalfa, 17% CP Dehy	93.0	18.7	60.0	1.30	0.26	\$6.30	\$5.86	\$117	\$114	\$110
Barley	89.0	13.9	83.0	0.05	0.37	\$5.97	\$5.31	\$106	\$103	\$100
Beans, Navy	90.0	25.4	83.0	0.29	0.54	\$8.54	\$7.68	\$154	\$149	\$144
Beet Pulp	92.0	9.0	78.0	0.32	0.26	\$4.73	\$4.36	\$87	\$84	\$82
Blood Meal	92.0	87.2	66.0	0.75	0.11	\$20.11	\$18.50	\$370	\$359	\$348
Brewers Grains,Dried	93.0	26.0	67.0	0.29	0.54	\$8.14	\$7.57	\$151	\$147	\$142
Brewers Grains, Wet	22.0	26.0	73.0	0.29	0.54	\$8.33	\$1.83	\$37	\$36	\$34
Corn,Shelled 15% Moist	85.0	10.2	88.0	0.02	0.30	\$5.29	\$4.50	\$90	\$87	\$85
Corn, H.M. Shelled	70.0	10.2	88.0	0.02	0.30	\$5.29	\$3.70	\$74	\$72	\$70
Corn Screenings(Variable)	88.0	8.0	80.0	0.10	0.25	\$4.54	\$4.00	\$80	\$78	\$75
Corn Cobs, Ground	90.0	3.0	50.0	0.10	0.15	\$2.43	\$2.19	\$44	\$42	\$41
Ear Corn, 15% Moisture	85.0	9.3	84.0	0.04	0.26	\$4.94	\$4.20	\$84	\$81	\$79
Ear Corn, High Moist.	65.0	9.3	84.0	0.04	0.26	\$4.94	\$3.21	\$64	\$62	\$60
Canola Meal	89.0	40.5	74.2	0.38	1.10	\$11.97	\$10.65	\$213	\$207	\$200
Corn Gluten Feed,Dried	90.0	21.5	80.0	0.18	1.00	\$8.16	\$7.34	\$147	\$142	\$138
Corn Gluten Feed, Wet	49.0	21.5	80.0	0.18	1.00	\$8.16	\$4.00	\$80	\$78	\$75
Corn Gluten Meal,40% CP	90.0	44.4	82.0	0.05	0.80	\$12.62	\$11.36	\$227	\$220	\$214
Corn Gluten Meal,60% CP	90.0	66.7	82.0	0.10	0.80	\$17.14	\$15.43	\$309	\$299	\$290
Cottonseed, Whole	92.0	22.5	98.0	0.14	0.56	\$8.43	\$7.76	\$155	\$151	\$146
Cottonseed Meal 41% CP	93.0	44.0	75.0	0.20	0.99	\$12.55	\$11.67	\$233	\$226	\$219
Dist. Grains 25-8	92.0	27.2	84.0	0.12	0.52	\$8.88	\$8.17	\$163	\$158	\$154
Dist. Grains 30-8	92.0	32.6	84.0	0.12	0.52	\$9.98	\$9.18	\$184	\$178	\$173
Fish Meal, 60% C.P.	92.0	66.7	69.0	5.60	3.16	\$20.48	\$18.84	\$377	\$365	\$354

