FEEDING VALUE OF WET DISTILLERS GRAINS FOR LACTATING DAIRY COWS WHEN CO-ENSILED WITH CORN SILAGE OR HAYCROP SILAGE

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Proper utilization of distiller's by-products as a feed ingredient has the potential to make Indiana's livestock industry significantly more attractive and competitive in domestic and global markets. Anticipated increases in the price of corn may be offset by readily available by-products, particularly corn distiller grains with solubles (DGS). The use of DGS in rations fed to ruminants is not novel. Changes in the availability and pricing are creating a market situation that greatly favors the use of DGS in Indiana. Therefore, it is critical that proper production, storage and feeding strategies for use of DGS are in place to enable small and medium-size operations to implement DGS feeding, while maintaining the quality standards of products and ensuring sustainability of these livestock industries. Activities at Purdue University are currently focused on determining the best storage and feeding strategies to enable small and medium sized dairy and beef producers to utilize DGS. This particular research summary focuses on our initiatives to evaluate co-ensiling strategies that enable effective use of wet distiller's grains with solubles (WDGS) in rations fed to lactating dairy cattle.

Background

Increasing bio-fuel production is a priority for federal and state governments as a strategy to decrease our nation's dependence on foreign oil. Price increases for the commodities used to produce bio-fuels are projected to increase with demand. Consequently a dramatic shift in feeding and production practices throughout the livestock industry is anticipated.

During the next several years there will be an estimated 1.4-1.9 million tons of DDGS produced by the ethanol industry expansion in Indiana. Distiller's grains can be effectively and economically used to meet protein requirements of ruminant animals. Wet distiller's grains are not an attractive option for small- to medium-sized dairy and beef producers due to the delivery volume needed to obtain favorable pricing, and limitations in storage length, and form.

One of the greatest limitations to the use of WDGS is storage and 'shelf life' Because WDGS is contains as much as 50% moisture it is susceptible to spoilage that results in reduced palatability and storage losses. Storage that limits surface oxygen exposure can be used to prolong storage life. The high moisture content presents a problem when stored in piles due to seepage and the density of WDGS exceeds the tensile strength of bag silos (Ag Bags). In many cases the use of WDGS is limited to operations that are able to utilize a semi-trailer load during a 7-10 day period. Therefore given a safe inclusion level of WDGS of 30-40% (dry matter basis) in most dairy rations the storage and handling issues described above act to limit the use of WDGS on small to medium-sized dairy operations. Therefore we have worked to provide options for storage of WDGS so that this feed resource can be used by small and medium-sized dairy operations. Our desire is that this information will help provide stability and sustainability to small and medium-sized operations and rural communities in the midst of a rapidly evolving and unstable era of production agriculture.

The objectives of this research were: 1) Develop and evaluate methods that will economically and effectively extend storage time (shelf-life) of bio-fuel co-products using complementary regional feedstuffs. 2) Determine the nutritive value of stored feeds containing bio-fuel co-products for cattle.

Experimental Methods

Two separate experiments were conducted to determine the effectiveness of co-ensiling strategies using WDGS with local feedstuffs. Experiment 1 evaluated the effects of co-ensiling WDGS with whole plant chopped corn and Experiment 2 evaluated the potential for co-ensiling with wilted haycrop silage.

Experiment 1: Coensiling WDGS with Corn

Whole plant corn fodder was harvested and either ensiled separately in an AgBag or was mixed in a TMR mixer at a ratio of 66:34 corn:WDGS and co-ensiled in an AgBag. Bags were opened after a minimum of 3 weeks and the value of the material was determined for lactating dairy cows in a feeding and production trial. The value of the WDGS corn fodder co-ensiled material (Corn Co-ensilage) was compared to a diet (Control) in which the individual feed ingredients were added at the time of mixing. Rations were balanced to meet NRC requirements based on milk production, composition and body weight, and fed as a total mixed ration with corn grain, soyhulls, grass hay and minerals and vitamins. Therefore the Control and Corn Co-ensilage diets contained the same proportions of WDGS and corn silage but only differed in regard to the calendar date when they were combined. The diets are shown in Table 1.

Experiment 2: Co-ensiling WDGS with Wilted Grass

Mostly grass mixed forage was harvest as haycrop silage (moisture) and either ensiled separately in an AgBag or mixed in a TMR mixer at a ratio of 37:63 haycrop silage:WDGS and co-ensiled in an AgBag. Bags were opened after a minimum of 3 weeks and the nutritive value of the feed was determined for lactating dairy cows. The value of the WDGS haycrop co-ensiled material (Haycrop Co-ensilage) was compared to a diet (Control) in which the individual feed ingredients were added at the time of mixing. Rations were balanced to meet NRC requirements based on milk production, composition and body weight, and fed as a total mixed ration with corn grain, soyhulls, grass hay and minerals and vitamins. Similar to experiment 1 the Control and Haycrop Co-ensilage diets contained the same proportions of WDGS and haycrop silage but only differed in regard to the calendar date when they were combined. The diets are shown in Table 1.

Experiments 1 and 2: Animals, Management and Data Collection

Co-ensilage feeds were evaluated using 32 mid-lactation Holstein cows in two separate experiments. Cows were housed in individual tie stalls. Milk production and feed intake were determined daily and milk composition was determined from samples taken once per week.

Sixteen cows were used for each co-ensilage evaluation. Cows were selected from the Purdue Dairy Research Center herd and used in a 3-period switchback design consisting of 21-day periods. At the beginning of the experiment eight cows received the co-ensilage diet and the remaining 8 cows were assigned to the control diet. The periods consisted of 14 days of adaptation to the diets followed by 7 days of data collection. At the conclusion of period 1 the cows were switched to the opposite treatment and the experiment continued with data collection during the last 7 days of period 2. Cows were then switched to their original treatment groups for the remaining 21 days of the experiment. Periods consisted of 3 contiguous 21 days.

Table 1. Ingredients and nutrient composition of diets.

	Treatment			
	Corn		Haycrop	
Item	Control	Co-ensilage	Control	Co-ensilage
Ingredient[1]				
Alfalfa Hay	5.03	5.01	5.03	5.01
Corn silage	33.28	2.73	33.28	33.25
Soyhulls	4.19	4.19	4.19	4.19
High moisture corn	10.55	10.54	10.55	10.54
Fishmeal	0.43	0.43	0.43	0.43
Soybean meal (48%)	3.77	3.77	3.77	3.77
Megalac R	0.46	0.46	0.46	0.46
Mineral supplement	7.16	7.15	7.16	7.15
Alfalfa haylage[2]	19.50	19.48		10.25
Direct cut haycrop silage			19.50	
Wet distillers grains (WDGS)	15.63		15.63	
Corn co-ensilage[3]		46.27		
Haycrop co-ensilage[4]				24.95
Total WDGS in diet	15.63	15.63	15.63	15.63
Nutrient				
CP	15.9	15.9	15.9	15.9
ADF	23.0	20.0	21.9	20.0
NDF	36.0	32.2	35.6	32.2
NEL, Mcal/lb.	0.70	0.68	0.69	0.68

[1] % DM. unless noted otherwise.
[2] Haycrop silage = wilted ensiled haylage (experiment 1) or direct cut ensiled (experiment 2) .
[3] Co-ensiled whole plant and WDGS (66:34 on dry basis).
[4] Co-ensiled haycrop silage and WDGS (37:63 on dry basis).

Results

There were no visual indications of mold or spoilage when Ag bags containing individual feeds and co-ensiled materials were opened. Analysis of co-ensiled feeds and corn silage and haycrop silage is given in Table 2. The moisture content of the haycrop silage was greater than targeted (65%) consequently sins of molding were observed for the haycrop silage. There were no similar indications for the haycrop co-ensilage.

Milk production, milk composition and feed intake did not differ for cows fed corn distillers grains that were mixed in the diet at time of feeding (Corn Control diet) or when WDGS was mixed with corn at the time of ensiling and fed as a component of the TMR (Table 3).

When haycrop forage was direct cut, ensiled and mixed with WDGS at feeding the cows ate less feed and produced significantly less milk (~ 5 lbs less) than if the same forage was co-ensiled with WDGS and fed as a component of the TMR.

Table 2. Nutrient composition of individual feeds or co-ensiled products.

	Corn		Haycrop		WDGS
Item	Silage	Co-ensilage[1]	Silage	Co-ensilage[2]	
Ingredient [3]					
DM, % as fed	35.51	37.25	30.60	36.42	40.1
CP	9.14	15.83	17.89	25.36	30.6
ADF	23.22	18.77	28.14	19.71	13.2
NDF	39.53	34.83	43.64	37.23	27.1
Fat	2.82	5.76	2.60	14.90	19.0
NFC	43.77	38.26	26.15	27.62	23.8
Ash	4.74	5.32	9.72	7.19	5.70
Ca	0.33	0.54	1.35	0.54	0.09
P	0.26	0.49	0.45	0.76	0.96
Mg	0.19	0.31	2.46	0.49	0.44
K	1.09	0.96	2.46	1.89	1.18
NEl, Mcal/lb	0.76	0.81	0.73	0.84	1.10

[1] Co-ensiled whole plant and WDGS (66:34 on dry basis) .
[2] Co-ensiled haycrop silage and WDGS (37:63 on dry basis).
[3] % DM. unless noted otherwise.

Table 3. Dry matter intake, milk production and composition

Item	Treatment: Corn Control	Corn Co-ensilage	Corn SE	Haycrop Control	Haycrop Co-ensilage	Haycrop SE
DMI, lbs/d	50.2	49.8	0.8	47.6	52.0*	0.7
Milk, lbs/d	79.21	78.59	1.49	78.0	82.2*	1.46
Milk composition, lbs/d						
Milk fat, lb/d	2.50	2.46	0.11	2.45	2.24	0.08
Milk protein, lb/d	2.08	2.11	0.06	2.03	2.05	0.05
Milk lactose, lb/d	3.21	3.22	0.11	3.26	3.26	0.07
Milk solids, lb/d	8.44	8.44	0.28	8.38	8.20	0.17
Milk composition, %						
Milk fat, %	3.10	3.08	0.10	3.15	2.85*	0.12
Milk protein, %	2.63	2.63	0.04	2.62	2.64	0.05
Milk lactose, %	4.03	4.03	0.07	4.17	4.14	0.06
Milk solids, %	10.57	10.55	0.18	10.75	10.44	0.18
SCC, 1,000 cells/ml	92	89	16	76	240	90
MUN, mg/dL	9.37	11.21*	0.37	9.85	11.19*	0.33
BW change, lbs	5.7	12.5	4.4	12.1	14.1	3.7
BCS change	0.0	0.1	0.0	0.0	0.1	0.0

* denotes differences (P < 0.05) between control and co-ensilage (within co-ensilage type)

Conclusions, Implications and Opportunities

The goal of this research was to evaluate a system that would permit small and mid-sized dairy producers (50 to 100 cows) to utilize WDGS in a feeding program. The inclusion rate of wet distillers is safely limited to approximately 15 to 20% of the ration dry matter. Therefore on whole farm basis the use of WDGS by small producers may be limited because the total amount that can be fed daily is mismatched with the delivery quantities required to take advantage of favorable pricing. Because the storage interval for WDGS is limited (usually 7 to 10 days) before spoilage occurs small and medium sized producers may not be able to effectively utilize WDGS. Due to the bulk density of WDGS direct storage in AgBags is not possible. Co-ensiling WDGS with low quality forages has been shown by other researcher to be an effective mode of storage however the value of such co-ensiled products in rations for high producing dairy cows may be limited. Therefore, our objective in co-ensiling WDGS with corn silage was to provide a vehicle to reduce the density and extend the storage life of WDGS in a system that was amenable to small and medium sized dairy producers. Data from the present study indicates that the feeding value of WDGS when co-ensiled with corn or when fed alone is equivalent and therefore provides and option for small and medium sized producers in utilizing WDGS.

Forage quality is often limited due to conditions at harvest. Weather conditions can result in a necessity to harvest at less than optimal moisture for preservation or a less than ideal maturity for optimal nutrient quality. We extended the potential for co-ensiling WDGS with forages to include haycrop forages. Forage was harvested in this experiment in late fall when daylight and temperature frequently limit the ability to dry forage down to a moisture content that will ensure preservation. Our experimental conditions used mixed legume forage that was direct cut and co-ensiled with WDGS at a target moisture content of 65% for the combined material. We were unsuccessful in drying the forage to similar moisture content and placed it in the silos at 30% dry matter. Consequently the forage when preserved alone showed evidence of reduced keeping quality but when direct cut grass was co-ensiled with WDGS there was no evidence of molds and cows ate more feed and produced more milk. At least two factors may be responsible for the beneficial effects of WDGS to improve the feeding value of direct cut forage 1) the moisture content was reduced by the addition of WDGS and 2) WDGS is acidic due to the addition of acids at the termination of the corn ethanol production process. Therefore the starting pH of the co-ensiling process is likely to be lower and therefore reduces the likelihood of growth of undesirable bacteria (Clostridia) during the ensiling process.

These data indicate the feeding value of corn silage and WDGS is not altered when combined at the time of feeding or premixed and co-ensiled. The feeding value of direct cut haycrop forage is considerably enhanced when co-ensiled with WDGS. Co-ensiling with corn silage provides an option that will extend the storage life of WDGS, whereas co-ensiling with direct cut forage provides possibilities to increase the opportunities for forage harvest and storage when daylight or weather conditions are unfavorable for making dry hay or haylage.