

DDGS Nutrition for Dairy Cows

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Overview

- DDGS nutrient composition
- Feeding DDGS to dairy cattle
 - ◆ Dairy cows
 - ◆ Calves, heifers, and dry cows
- Current recommendations



Introduction

- Increased ethanol production from corn has resulted in increased availability of distillers grains with solubles (DGS).
- Recognized as good source of protein, energy (from lipids and fermentable carbohydrates), and minerals.
- DGS is a less expensive alternative to corn and soybean meal lowering the cost of the diet.



Nutrient Composition of DDGS

Nutrient	NRC (1989)	NRC (2001)	Common Range
CP, % of DM	25	29.7	28-32
RUP, % of CP	47	variable	47-57
NDF, % of DM	44	38.8	28-44
ADF, % of DM	18	19.7	14-24
Fat, % of DM	10.3	10	10-15
Starch, % of DM	5-8
NE _L , Mcal/kg	2.04	1.97	2.27*

*Birkelo, C.P. et al., 2004.



Nutrient Composition of DDGS

Nutrient	NRC (1989)	NRC (2001)	Common Range
Ca, % of DM	0.15	0.22	0.03-0.15
P, % of CP	0.71	0.83	0.60-0.95
Mg, % of DM	0.18	0.33	0.30-0.35
K, % of DM	0.44	1.10	0.70-1.10
S, % of DM	0.33	0.44	0.30-0.80



Protein

- Averages 30% CP (DM basis)
- Good source of rumen-undegraded protein (RUP)
 - ◆ Typically 50 to 55% (as a % of CP), however values may be greater than 60%.
- Protein quality
 - ◆ Newer DDGS is higher in quality.
 - ◆ Lysine is first limiting amino acid.
- Will the protein quality of DDGS affect milk production and composition?



Fiber

- NDF – 28 to 44% (DM basis)
- Not effective fiber
- Small particle size
- Highly fermentable in the rumen
- Does DDGS fiber affect milk composition?



Fat

- 10 to 15% lipid
- Corn lipid
 - ◆ Highly unsaturated (C18:2)
- Is there an impact on rumen function?
- Will fat in DDGS affect milk fat composition?



Minerals

- Can be highly variable.
- Phosphorus – 0.65 to 0.9%.
 - ◆ Phosphorus is readily available to animal.
 - ◆ Can replace inorganic sources of P.
- Sulfur – 0.3 to 0.80%.



Energy

- What is the energy value for DGS?
- NE_L of DGS
 - ◆ NRC (1989) = 2.04 Mcal/kg
 - ◆ NRC (2001) = 1.97 Mcal/kg
- Birkelo et al., (2004)
 - ◆ DGS NE_L = 2.27 Mcal/kg of DM
 - ◆ NRC underestimates NE_L – 10 to 15%



Why Does Composition Vary?

- Many factors can affect nutrient variability in DDGS.
 - ◆ Type and quality of grain
 - ◆ Milling and fermentation processes
 - ◆ Drying temperature
 - ◆ Amount of solubles added back to the wet DGS prior to drying



Why Does Composition Vary?

Nutrient	Ratio of DDG to CDS				CDS ¹
	100:0	87:13	73:27	60:40	
% of DM	100:0	87:13	73:27	60:40	CDS ¹
CP	34.3	32.9	32.0	30.1	22.4
NDF	40.2	37.4	34.6	30.8	5.6
Fat	8.9	11.1	13.4	14.5	18.6
Ash	2.4	3.4	4.6	5.8	11.6
P	0.44	0.62	0.78	0.95	1.94
S	0.53	0.67	0.78	0.92	1.66
RUP, % of CP	66.1	62.8	60.9	58.1	---

¹Condensed distillers solubles (CDS).
Source: South Dakota State University.



Questions Regarding DDGS in Dairy Cow Diets

- How much DDGS can be included into dairy cow diets?
- How does inclusion of DDGS affect milk composition?
 - ◆ Milk fat %
 - ◆ Milk protein %
- What dietary factors limit the inclusion of DDGS?



High Inclusion Rates of DDGS

- Hippen et al. (2004)
 - ◆ DDGS included at 0, 13, 27, and 40% of diet.
 - ◆ Diets were not iso-nitrogenous (16.5 to 18.9%, but were formulated to be equal in RDP (10.7%), but increasing in RUP (5.7 to 8.2%)
 - ◆ Diets consisted of:
 - ◆ 43% forage:57% concentrate
 - ◆ Forage - corn silage (65%):alfalfa/grass hay (35%)



High Inclusion Rates of DDGS

Item	DDGS in Diet, % DM				SEM
	0	13	27	40	
DMI, kg/d	26.9 ^a	29.9 ^b	26.7 ^a	25.1 ^a	1.6 ^{L,Q}
Milk, kg/d	40.7 ^a	41.7 ^a	39.1 ^{ab}	36.3 ^b	1.6 ^L
Fat, %	3.40 ^a	3.18 ^b	3.19 ^b	3.10 ^b	0.09 ^L
Protein, %	2.96	3.03	3.01	3.02	0.06

^{a,b}When superscripts differ ($P < 0.05$).

^LLinear treatment effect ($P < 0.05$).

^QQuadratic treatment effect ($P < 0.05$).



DDGS as a Fiber Source

- Cyriac et al. (2005)
 - ◆ Replaced corn silage with non-forage fiber from DDGS in dairy cows diets at 0, 7, 14, and 21% of the diet.
 - ◆ Forage NDF decreased 25.0, 21.7, 18.3, and 14.9% as corn silage was replaced with non-forage NDF.
 - ◆ Total diet NDF averaged 30 to 32% NDF.



Diet Ingredients

Item	DDGS in diets, % of DM			
	0	7	14	21
Alfalfa hay	15	15	15	15
Corn silage	40	33	26	19
Ground corn	25	25	25	25
DDGS	0	7	14	21
Soy hulls	0	4.8	9.6	14.4
Soybean meal	9.4	6.8	4.1	1.5
SoyPLUS	6.4	4.9	3.3	1.8
Megalac	2.1	1.4	0.7	0
Min. & Vit.	2.1	2.2	2.2	2.3



DDGS as a Fiber Source

Item	DDGS in Diet, % DM				SEM
	0	7	14	21	
DMI, kg/d	19.3	20.6	21.5	22.8	0.80 ^L
Total NDFI, kg/d	5.8	6.3	6.6	7.3	0.25 ^L
Forage NDFI, kg/d	4.8	4.5	3.9	3.4	0.16 ^L

^LLinear treatment effect ($P < 0.01$).



DDGS as a Fiber Source

Item	DDGS in Diet, % DM				SEM
	0	7	14	21	
Milk, kg/d	32.9	33.4	33.9	34.0	1.3
Fat, %	3.34	3.25	3.04	2.85	0.08 ^L
Protein, %	2.82	2.90	2.93	3.04	0.05 ^L
MUN, mg/dl	14.4	14.2	14.9	14.7	0.43
ECM/DMI	1.67	1.57	1.49	1.37	0.06 ^L

^LLinear treatment effect ($P < 0.01$).



DDGS as a Replacement for Starch

- Ranathunga et al. (2008)
 - ◆ Replaced starch from corn with non-forage fiber from DDGS to evaluate milk production, milk composition, and feed intake and efficiency in lactating dairy cows.
 - ◆ Basal diet included 27% corn silage, 22% alfalfa hay, and 49% concentrate.



Diet Ingredients

Item	Starch in diet, % of DM			
	29	26	23	20
Corn Silage	27.0	27.0	27.0	27.0
Alfalfa Hay	22.0	22.0	22.0	22.0
Ground Corn	35.0	29.3	23.6	17.9
SBM 44%	4.5	3.2	1.9	0.6
Soyplus	8.4	5.6	2.8	0.0
DDGS	0.0	7.0	14.0	21.0
Soybean Hulls	0.0	3.2	6.4	9.6
Energy Booster	1.4	1.0	0.7	0.4
Min. & Vit. Mix	1.7	1.7	1.7	1.7



DDGS as a Replacement for Starch

Item	Starch in diet, % of DM				SEM
	29	26	23	20	
DMI, kg/d	25.6	25.0	23.4	22.9	0.72 ^L
Milk, kg/d	39.4	37.4	37.7	38.3	1.03
Fat, %	3.14	3.22	3.29	3.24	0.11
Protein, %	2.97	2.96	3.01	2.94	0.04
MUN, mg/dL	11.7	12.2	11.6	12.2	0.38
ECM/DMI	1.47	1.47	1.54	1.61	0.06 ^{LT}

^LLinear treatment effect ($P < 0.01$).

^{LT}Linear treatment effect ($P < 0.10$).



DDGS as a Protein Source

- Most previous research analyzed DGS as a source of protein and alternative source of RUP.
- Replaced soybean meal (SBM) or combination of SBM and corn.



DDGS as a Source of RUP

- Pamp et al. (2006)
 - ◆ Investigated the effect of source and level of RUP in lactating diets by comparing dried DG to soybean protein.
 - ◆ DGS replaced a combination of SBM (44%), expeller soybean meal, extruded soybeans, and soyhulls.
 - ◆ Basal diet included 38.5% corn silage, 16.5% alfalfa hay, and 45% concentrate.



Diet Ingredients, % of DM

Ingredients	Diets				
	Ctrl	MPS	MPD	HPS	HPD
Corn silage	38.5	38.5	38.5	38.5	38.5
Alfalfa hay	16.5	16.5	16.5	16.5	16.5
DDGS	0	0	11.0	0	22.0
Ground corn	23.4	21.6	18.0	20.0	12.6
SBM 44%	6.3	4.5	4.0	2.8	1.8
Soyplus	0	6.0	3.2	11.7	6.4
Extruded beans	5.0	5.0	2.5	5.0	0
Soybean hulls	8.0	5.4	4.1	3.2	0
Vitamin/mineral mix	2.3	2.3	2.3	2.3	2.3



Protein Composition, % DM

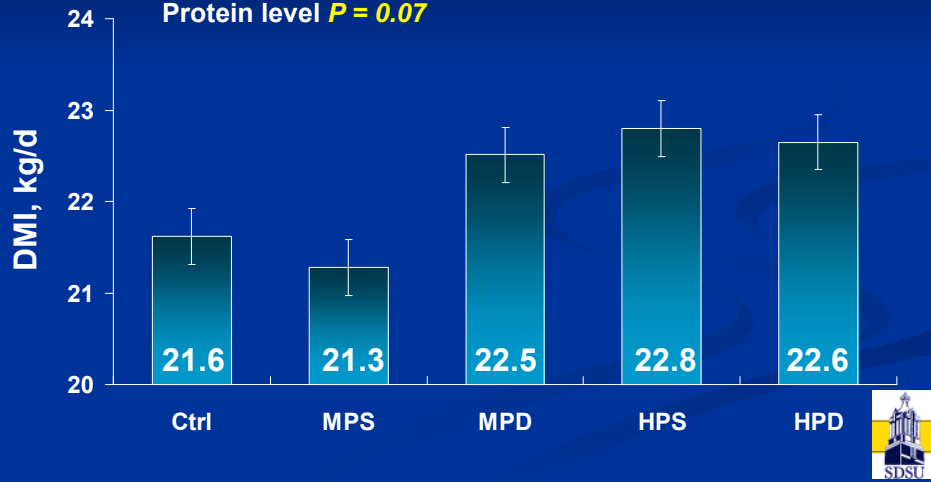
Nutrient ¹	Diets				
	Ctrl	MPS	MPD	HPS	HPD
CP	15.3	16.8	16.8	18.3	18.3
RDP	10.0	10.0	10.0	10.0	10.0
RUP	5.3	6.8	6.8	8.3	8.3

¹Target values calculated from NRC 2001



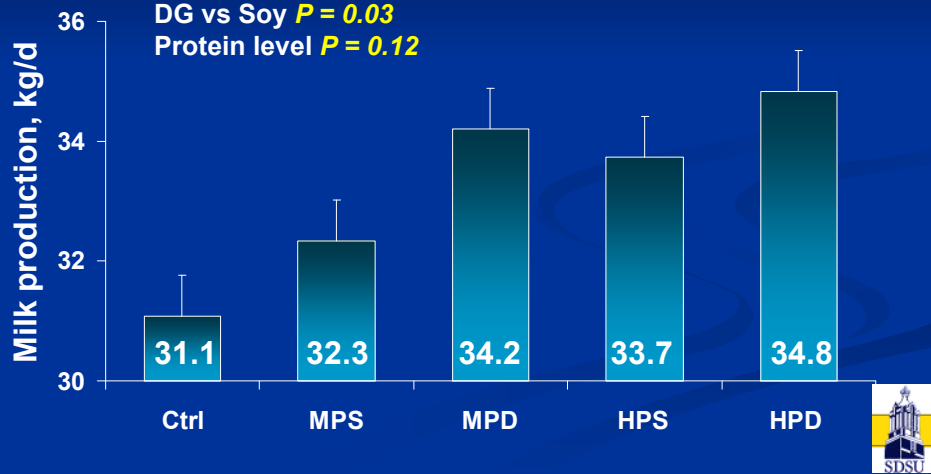
Effect of Treatment on DMI

Ctrl vs added RUP $P = 0.19$
DG vs Soy $P = 0.25$
Protein level $P = 0.07$

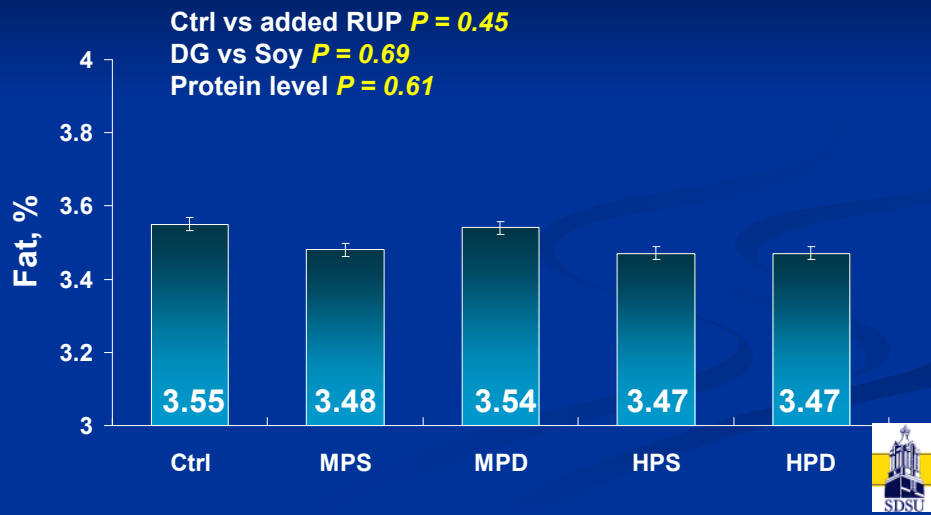


Effect of Treatment on Milk Production

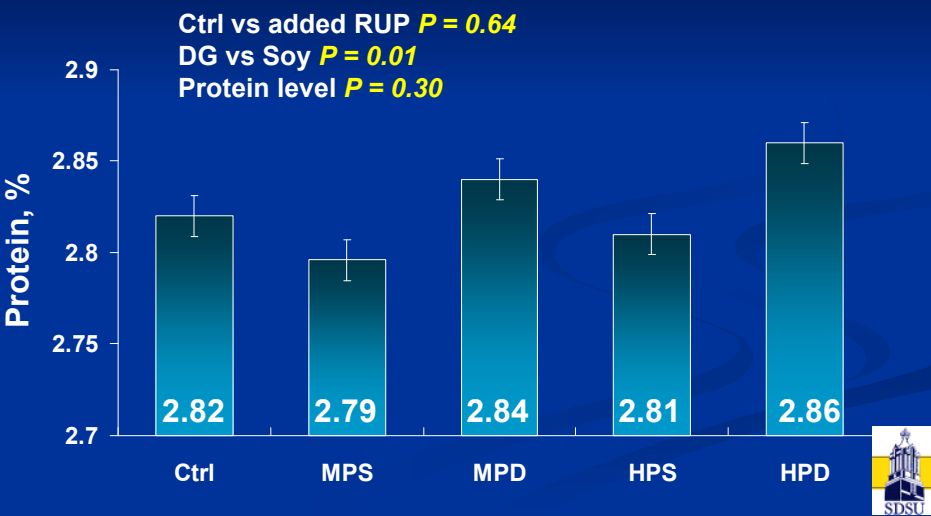
Ctrl vs added RUP $P = 0.001$
DG vs Soy $P = 0.03$
Protein level $P = 0.12$



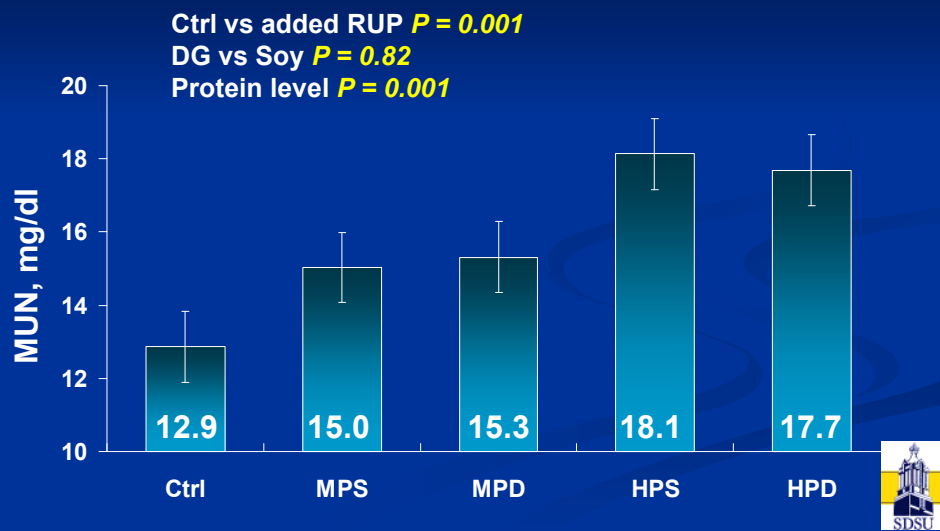
Effect of Treatment on Fat Percentage



Effect of Treatment on Protein Percentage



Effect of Treatment on MUN



Inclusion of de-oiled DGS

- Mjoun et al. (2008)
 - ◆ Investigated the inclusion of a de-oiled (low fat) DDGS (dDGS) in dairy cow diets at similar dietary CP concentrations.
 - ◆ dDGS replaced a combination of SBM (44%), expeller soybean meal, and soyhulls.
 - ◆ Basal diet included 38% corn silage, 12% alfalfa hay, and 50% concentrate.



Dietary Composition

Ingredient	Control	10% dDGS	20% dDGS	30% dDGS
Corn silage	38.0	38.0	38.0	38.0
Alfalfa hay	12.0	12.0	12.0	12.0
Ground corn	17.6	17.3	16.8	16.3
De-oiled DDGS	0.0	10.0	20.0	30.0
Soybean meal, 44%	8.1	5.3	2.7	0.0
Expeller soybean meal	9.3	6.2	3.1	0.0
Soybean hulls	12.0	8.0	4.0	0.0
Energy Booster	0.44	0.62	0.84	0.98
Vitamins & Minerals*	2.00	2.07	2.13	2.21

*Includes: Limestone, Dicalcium phosphate, Salt, Magnesium oxide, Vitamin Premix



Inclusion of de-oiled DGS

Item	Inclusion of dDGS, % of DM				SEM
	0	10	20	30	
DMI, kg/d	22.7	22.9	24.5	22.2	0.84
Milk, kg/d	34.5	34.8	35.5	35.2	0.62
Fat, %	3.18	3.40	3.46	3.72	0.18 ^L
Protein, %	2.99	3.06	3.13	2.99	0.04 ^Q
MUN, mg/dL	15.8	14.6	13.7	13.0	0.42 ^L
ECM/DMI	1.46	1.52	1.47	1.63	0.05 ^L

^LLinear treatment effect ($P < 0.05$).

^QQuadratic treatment effect ($P < 0.05$).



How much DDGS can we feed?



Meta-analysis

- 23 studies with 96 treatment comparisons
 - ◆ Studies were from 1982 to 2005.
 - 80's: 5 studies with 14 treatment comparisons.
 - 90's: 8 studies with 41 treatment comparisons.
 - 00's: 10 studies with 41 treatment comparisons.
 - ◆ Considered all studies that evaluated the inclusion of distillers grains.
- Objective was to determine the effect of feeding distillers grains on DMI, milk yield and milk fat and protein composition.



Dry Matter Intake, kg/d

Inclusion of DGS	Dried	Wet	All
0%	23.5 ^c	20.9 ^b	22.2 ^b
4 - 10%	23.6 ^{bc}	23.7 ^a	23.7 ^a
10 - 20%	23.9 ^{ab}	22.9 ^{ab}	23.4 ^{ab}
20 - 30%	24.2 ^a	21.3 ^{ab}	22.8 ^a
> 30%	23.3 ^{bc}	18.6 ^c	20.9 ^{bc}
SEM	0.8	1.3	0.8

(Meta analysis, Kalscheur 2005)



Milk production, kg/d

Inclusion of DGS	Dried	Wet	All
0%	33.2	31.4	33.0
4 - 10%	33.5	34.0	33.4
10 - 20%	33.3	34.1	33.2
20 - 30%	33.6	31.6	33.5
> 30%	32.2	31.6	32.2
SEM	1.5	2.6	1.4

(Meta analysis, Kalscheur 2005)



Milk Composition, %

Inclusion of DGS	Fat %	Protein %
0%	3.39	2.95 ^a
4 - 10%	3.43	2.96 ^a
10 - 20%	3.41	2.94 ^a
20 - 30%	3.33	2.97 ^a
> 30%	3.47	2.82 ^b
SEM	0.08	0.07

(Meta analysis, Kalscheur 2005)



Fat % Decreased Only When Not Fed Sufficient Effective Fiber

% forage in diet	LS Mean (%)	Response (%)	<i>P</i> <
< 50%	3.21 ^b	-	
50%	3.50 ^a	0.287	0.01
> 50%	3.45 ^a	0.239	0.01

(Meta analysis, Kalscheur 2005)



What About Youngstock and Dry Cows?



DDGS for Calves & Heifers

■ Calves

- ◆ Successfully replaced grain and protein supplement at 28 & 56% of the starter diet.

■ Growing dairy heifers

- ◆ DDGS can be included at 20 to 30% of the diet.
- ◆ Increase forage in diet to balance the nutrient requirements or restrict intake in order to meet but not exceed energy requirements.
- ◆ If animals are overfed energy, over-conditioning can result.



DDGS for Dry Cows



- ◆ DDGS can be included at a low inclusion rate (10%) if diet is balanced with low nutrient feeds (such as roughages).
- ◆ Do not allow cows to over-condition during the dry period.



Current Recommendations

- Nutrient composition can vary from plant to plant and with plant – obtain nutrient composition.
- Nutrient composition can vary greatly for distillers (wet or dried) depending on the addition of condensed distillers solubles (CDS).
- High quality DDGS can potentially be included up to 20% of lactating cow diets.
 - ◆ Sufficient effective fiber must be included the diet.
 - ◆ Keep an eye an lysine adequacy.
 - ◆ Phosphorus should not exceed 0.38 to 0.40% of diet.



Current Recommendations

- Diets can potentially include DDGS greater than 20% of the diet, but effective fiber for normal rumen function to prevent milk fat depression must be sufficient.
- Inclusion of DDGS over 30% of the diet usually results in decreased animal performance.



Websites on DDGS

- Dairy information at SDSU website:
<http://dairysci.sdstate.edu/publications/topic.cfm>
Select "Distillers Grains" from topic menu.
- Email me at: kenneth.kalscheur@sdstate.edu



