Use of Distiller's Dried Grains with Solubles in Swine Feeds

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What is DDGS?

- Co-product of the dry-milling ethanol industry
  - Corn (maize) DDGS - Midwestern US
  - Wheat DDGS - Canada
  - Sorghum (milo) DDGS - Great Plains US
  - Barley DDGS
  - Rye DDGS

Production of DDGS

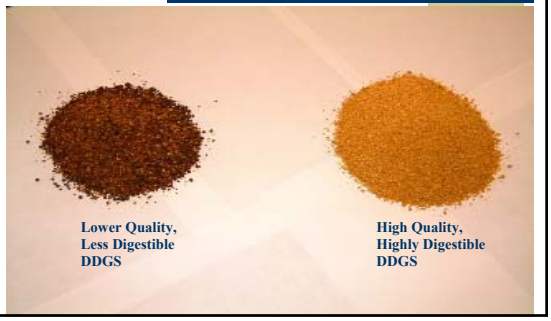
- Yeasts and enzymes are used to ferment the starch fraction of corn
- Ethanol and carbon dioxide are produced
- Distiller's grains and distiller's solubles are the residues remaining after fermentation
- These fractions are blended and dried to produce distiller's dried grains with solubles (DDGS)

Dry-Milling Average Ethanol Yield Per Bushel (25.4 kg) of Corn

- Ethanol 2.7 gallons (10.2 liters)
- DDGS 18 lbs (8.2 kg)
- CO_2 18 lbs (8.2 kg)

Slide courtesy of Ms. Kelly Davis, CVEC, Benson, MN

"New Generation" vs. "Old Generation" DDGS



Comparison of Energy Values for DDGS (88% Dry Matter Basis)

	"New" DDGS Calculated	"New" DDGS Trial avg.	"Old" DDGS Calculated	DDGS NRC (1998)
DE, kcal/lb	1582 Range 1550-1604	1600 Range 1349-1853	1546	1564
ME, kcal/lb	1434 Range 1400-1458	1527 Range 1279-1776	1405	1212

Corn (NRC, 1998): DE (kcal/lb) = 1580
ME (kcal/lb) = 1534

Comparison of Amino Acid Composition of DDGS (88% dry matter basis)

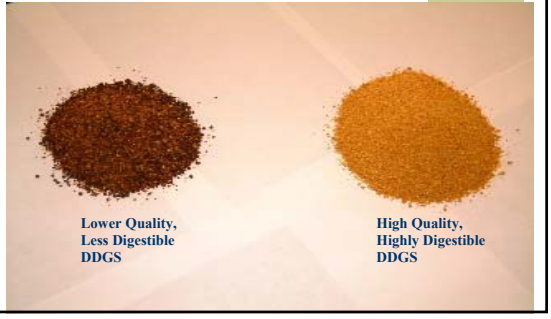
	"New" DDGS	"Old" DDGS	DDGS (NRC, 1998)
Lysine, %	0.75 (17.3)	0.47 (26.5)	0.59
Methionine, %	0.63 (13.6)	0.44 (4.5)	0.48
Threonine, %	0.99 (6.4)	0.86 (7.3)	0.89
Tryptophan, %	0.22 (6.7)	0.17 (19.8)	0.24
Valine, %	1.32 (7.2)	1.22 (2.3)	1.23
Arginine, %	1.06 (9.1)	0.81 (18.7)	1.07
Histidine, %	0.67 (7.8)	0.54 (15.2)	0.65
Leucine, %	3.12 (6.4)	2.61 (12.4)	2.43
Isoleucine, %	0.99 (8.7)	0.88 (9.1)	0.98
Phenylalanine, %	1.29 (6.6)	1.12 (8.1)	1.27

Values in ( ) are CV's among plants

Comparison of Apparent Ileal Digestible Amino Acid Composition of DDGS (88% dry matter basis)

	"New" DDGS	"Old" DDGS	DDGS (NRC, 1998)
Lysine, %	0.39	0.00	0.27
Methionine, %	0.28	0.21	0.34
Threonine, %	0.55	0.32	0.49
Tryptophan, %	0.13	0.13	0.12
Valine, %	0.81	0.45	0.77
Arginine, %	0.79	0.53	0.77
Histidine, %	0.45	0.26	0.40
Leucine, %	2.26	1.62	1.85
Isoleucine, %	0.63	0.37	0.64
Phenylalanine, %	0.78	0.60	0.96

"New Generation" vs. "Old Generation" DDGS



Correlation Between DDGS Color and Amino Acid Digestibility (r^2)

Amino acid	L*	a*	b*
Lys	.67	NS	.77
Cys	.67	NS	.74
Thr	.51	NS	.58

Comparison of Phosphorus Level and Relative Availability of DDGS
(88% dry matter basis)

	"New" DDGS	"Old" DDGS	DDGS NRC (1998)	Corn NRC (1998)
Total P, %	0.78 Range 0.62-0.87	0.79	0.73	0.25
P Availability, %	90 Range 88-92	No data	77	14
Available P, %	0.70	No data	0.56	0.03

Why is there so much interest in feeding DDGS to swine?

- "New Generation" DDGS is high in digestible nutrients
- Economical partial replacement for:
  - corn
  - soybean meal
  - dicalcium phosphate
- Increasing production and supply
- Unique properties
  - reduce P excretion in manure
  - increase litter size weaned/sow
  - gut health benefits?

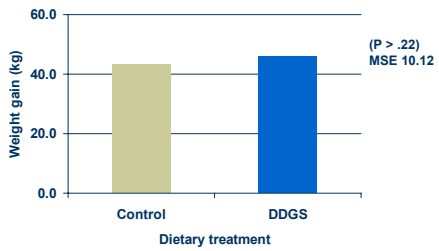
Maximum Inclusion Rates of "New Generation" DDGS in Swine Diets
(Based Upon University of Minnesota Performance Trials)

- Nursery pigs (> 7 kg)
  - Up to 25 %
- Grow-finish pigs
  - Up to 20% (higher levels may reduce pork fat quality)
- Gestating sows
  - Up to 50%
- Lactating sows
  - Up to 20%

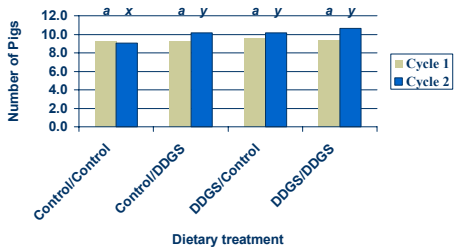
Assumptions: no mycotoxins
formulate on a digestible amino acid and available phosphorus basis

Feeding "New Generation DDGS to Sows"

Effect of Feeding a 50% DDGS Diet on Sow Weight Gain During Gestation (Reproductive Cycle 1)

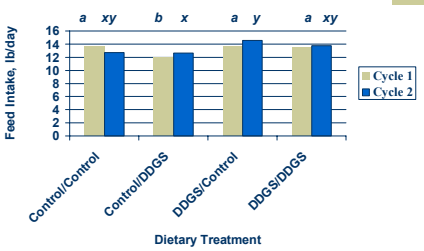


Effect of Feeding 0 or 50% DDGS Gestation Diets and 0 or 20% DDGS Lactation Diets on Pigs Weaned/Litter



a,b,x,y Different superscripts indicate significant difference (P < .10).

Effect of Dietary Treatment Combination on Sow Lactation ADFI



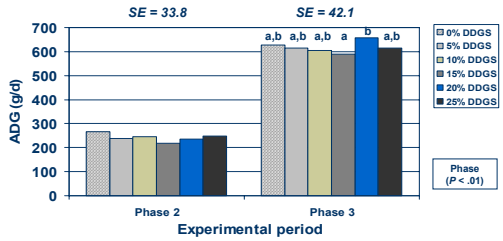
a,b,x,y Different superscripts indicate significant difference ($P < .10$).

Feeding "New Generation" DDGS to Weaned Pigs

Materials and Methods – Nursery Experiments

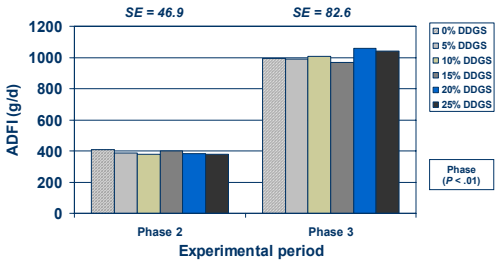
- Experiment 1
  - Pigs weaned at 19.0 ± 0.3 d of age
  - Weighed 7.10 ± 0.07 kg
- Experiment 2
  - Pigs weaned at 16.9 ± 0.4 d of age
  - Weighed 5.26 ± 0.07 kg
- Pigs were fed a commercial pelleted diet (d 0 to 3 postweaning)
- Phase II (d 4-17) and Phase III (d 18 – 35) diets were formulated on a digestible amino acid basis.
  - Diets contained 0, 5, 10, 15, 20, or 25% DDGS

Effect of DDGS Level on Growth Rate (Experiment 1)

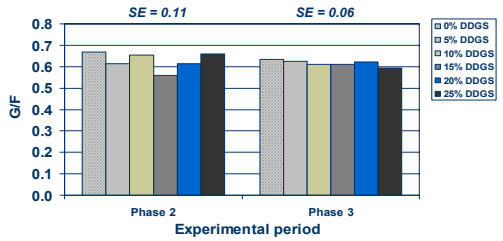


Means not sharing a common superscript letter are significantly different ($P < .05$)

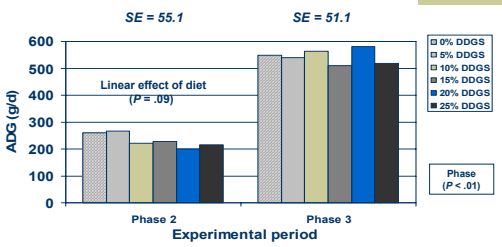
Effect of DDGS Level on ADFI (Experiment 1)



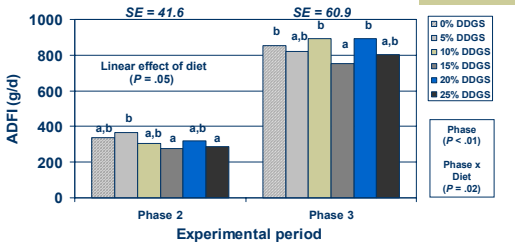
Effect of DDGS Level on Gain/Feed (Experiment 1)



Effect of DDGS Level on Growth Rate (Experiment 2)



Effect of DDGS Level on Feed Intake (Experiment 2)



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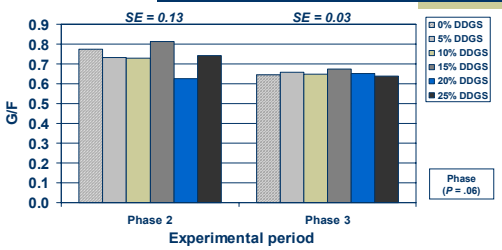
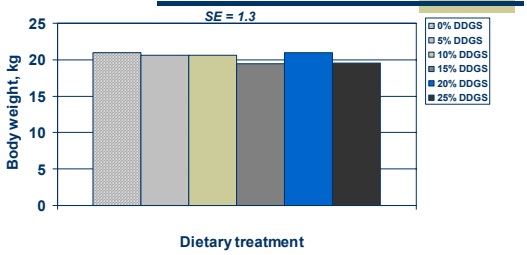
Effect of DDGS Level on Gain/Feed (Experiment 2)



Effect of DDGS Level on Final BW (Experiment 2)



Feeding "New Generation" DDGS to Grow-Finish Pigs

Fat Quality Characteristics of Market Pigs Fed Corn-Soy Diets Containing 0 to 30% DDGS

	0 %	10%	20%	30%
Belly thickness, cm	3.15^{a}	$3.00^{a,b}$	$2.84^{a,b}$	2.71^{b}
Belly firmness score, degrees	27.3^{a}	$24.4^{a,b}$	$25.1^{a,b}$	21.3^{b}
Adjusted belly firmness score, degrees	25.9^{a}	$23.8^{a,b}$	$25.4^{a,b}$	22.4^{b}
Iodine number	66.8^{a}	68.6^{b}	70.6^{c}	72.0^{c}

Means within a row lacking common superscripts differ ($P < .05$).

Formulation Methods for Diets Containing DDGS

- Total vs digestible amino acid basis
  - Maximum DDGS inclusion rate = 10%
    - if formulating on a total amino acid basis
  - Much higher DDGS inclusion rates (>10%)
    - if diets are formulated using digestible amino acids
- Total vs available phosphorus basis
  - Formulating diet on an available P basis increases economic benefit and reduces P content of manure

Cost Savings Depends on Diet Formulation Method Used

Comparison of Formulating DDGS Diets on a Total Lysine and P Basis vs. Digestible Lysine and Available P Basis

Ingredient	Typical Corn-SBM-Lysine Diet	10% DDGS Total Lysine Total P	10% DDGS Digestible Lysine Available P
Corn, lb	1463	1301	1286
Soybean meal 44%, lb	482	446	463
DDGS, lb	0	200	200
Dicalcium phosphate, lb	24	19	17
Limestone, lb	14	17	17
Salt, lb	6	6	6
L-lysine HCl, lb	3	3	3
VTM premix, lb	8	8	8
TOTAL, lb	2000	2000	2000
Total Cost, $	136.26	134.92	136.11
Difference, $	-	-1.34	-0.15

corn = $2.24/bu, DDGS = $100/ton, soybean meal 44% = $240/ton, dicalcium phosphate = $240/ton, limestone = $36/ton, salt = $6.00/cwt, L-lysine HCl = $2.35/lb, VTM premix = $1.17/lb

Quick Calculation of Feed Cost Savings

Thumb rule:

Additions/2000 lbs diet

+ 200 lbs DDGS x _____ $/lb = $_____
+ 3 lbs limestone x _____ $/lb = $_____
TOTAL ADDITIONS (A) $_____

Subtractions/2000 lbs diet

- 177 lbs corn x _____ $/lb = $_____
- 20 lbs SBM (44%) x _____ $/lb = $_____
- 6 lbs dical. phos. x _____ $/lb = $_____
TOTAL SUBTRACTIONS (S) $_____

(S – A) = Feed cost savings/ton by adding 10% DDGS to the diet

DDGS and Phytase are a Key Part of Manure Phosphorus Management

- Adding 20% DDGS to a corn-soy diet and formulating on an available P basis
  - can reduce manure P by > 12%
- Adding phytase to a corn-soy diet
  - increases P bioavailability from 15% to > 45%
- Lowering dietary P, adding 20% DDGS & phytase
  - can reduce manure P excretion by 40 to 50%

Diet Compositions and Cost Comparison from Adding 18.8% DDGS and Phytase

Ingredient	Corn-SBM- 3 lb Lysine	18.8% DDGS + Phytase
Corn, lb	1596.6	1272.6
Soybean meal 44%, lb	353.8	318.8
DDGS, lb	0.0	376.0
Dicalcium phosphate, lb	23.2	0.0
Limestone, lb	14.4	19.6
Salt, lb	6.0	6.0
L-lysine HCl, lb	3.0	3.0
VTM premix, lb	3.0	3.0
Phytase, 1000 FTU/lb	0.0	1.0
TOTAL, lb	2000.0	2000.0
Total Cost, $	120.28	120.46
Difference, $	-	+ 0.18

Does Feeding DDGS Improve Gut Health?

DDGS and Gut Health

- Field reports:
  - Beneficial effect of adding 5 to 10% DDGS in grow-finish diets
- DDGS contains low levels of soluble (0.7 %) and high levels of insoluble (42.2 %) fiber (Shurson et al., 2000)
  - Low soluble fiber diets may reduce the proliferation of pathogenic organisms in the GI tract (Hampson, 1999).
- DDGS contains components of yeast cells
  - May have nutraceutical properties

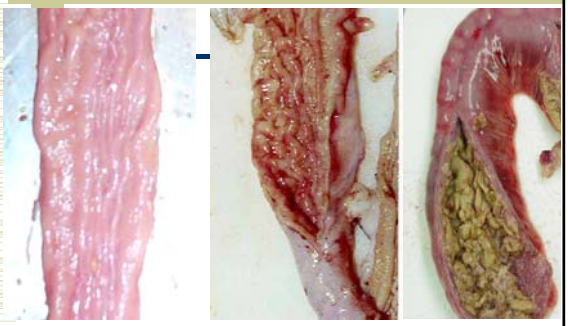
What is Ileitis?

- Porcine Proliferative Enteropathy
- Caused by *Lawsonia intracellularis*
  - Present in 96% of U.S. swine herds (Bane et al., 1997)
    - 28% of pigs affected (NAHMS, 2000)
  - Can be shed in infected pigs for up to 10 weeks
- Animals are infected by oral contact with feces from animals shedding the bacteria
- 7-10 days after infection:
  - Lesions of the intestinal wall begin to form
  - Lesions maximized around 21 days post-infection

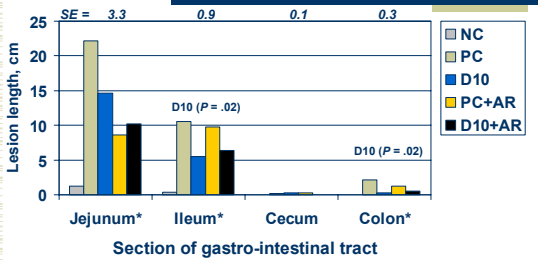
Clinical Forms of Ileitis

- Porcine Intestinal Adenomatosis (PIA)
  - Chronic form
  - Seen in growing pigs (6 - 20 weeks of age)
  - Decreased feed intake, lethargic
- Porcine Hemorrhagic Enteropathy (PHE)
  - Acute form, affects heavier pigs
    - Greatest frequency appears to be from 65 – 110 kg pigs
  - Massive intestinal hemorrhaging, bloody diarrhea, increase in mortality

Healthy **Ileitis**

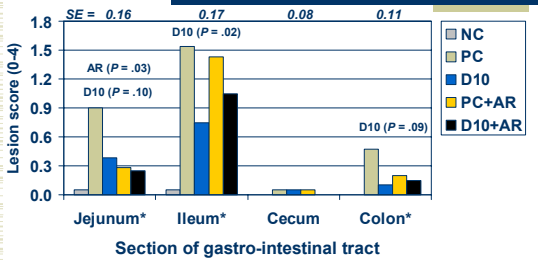


Effect of Dietary Treatment on Lesion Length (21 d Post-Challenge) Experiment 2



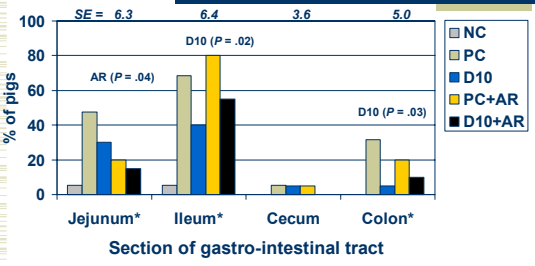
* Effect of disease challenge ($P < .01$).

Effect of Dietary Treatment on Lesion Severity (21 d Post-Challenge) Experiment 2



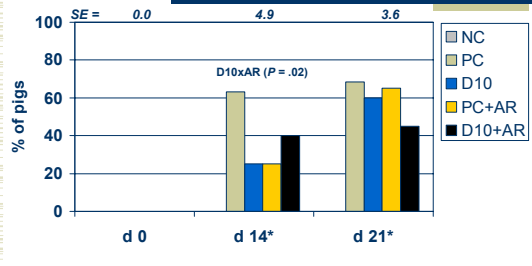
* Effect of disease challenge ($P < .01$).

Effect of Dietary Treatment on Lesion Prevalence (21 d Post-Challenge) Experiment 2



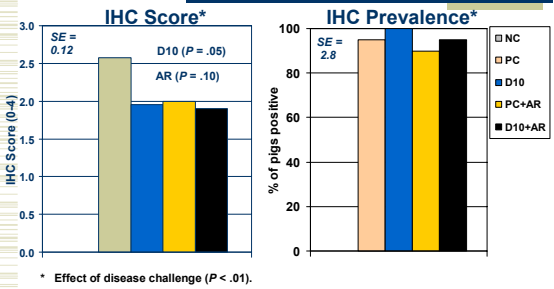
* Effect of disease challenge ($P < .01$).

Effect of Dietary Treatment on Fecal Shedding (PCR Analysis) Experiment 2



* Effect of disease challenge ($P < .01$).

Effect of Treatment on *L. intracellularis* Infection (IHC Analysis) Experiment 2



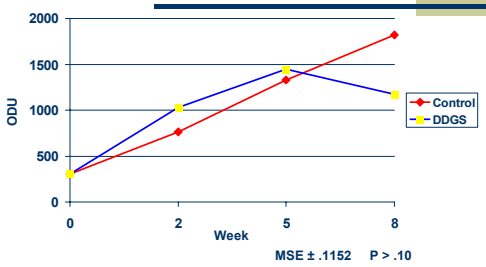
* Effect of disease challenge ($P < .01$).

Summary of Results, Experiment 2

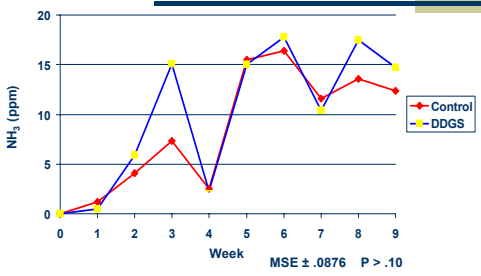
- Inoculation level was closer to goal
- DDGS inclusion (10%) or antimicrobial regimen had a positive effect on the pig's ability to resist an ileitis challenge
- No beneficial additive effects of combining DDGS and BMD®/Aureomycin® regimen

DDGS For Odor Control?

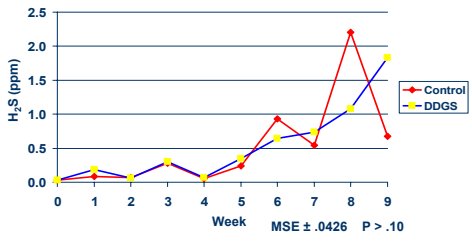
Effect of Feeding a 20% DDGS Diet on Manure Odor Detection Threshold



Effect of Feeding a 20% DDGS Diet on Ammonia Emissions



Effect of Feeding a 20% DDGS Diet on Hydrogen Sulfide Emissions



U of M DDGS Web Site www.ddgs.umn.edu

We have developed a DDGS web site featuring:

* research summaries
  - swine, poultry, dairy, & beef
  - DDGS quality
* presentations given
* links to other DDGS related web sites
* international audiences