The Feeding Value of U.S. Corn DDGS to Swine

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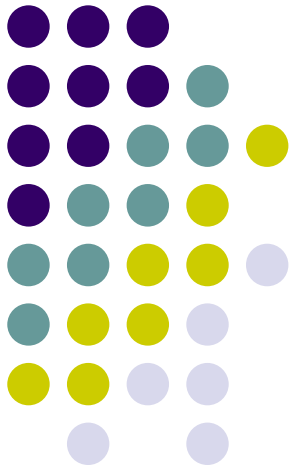
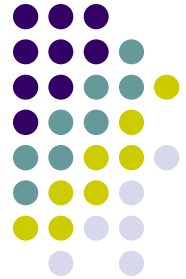


Why is there so much interest in feeding high quality DDGS to swine?

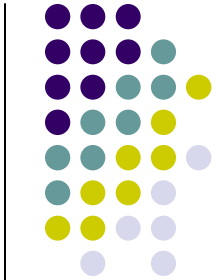


- High Quality DDGS is high in digestible nutrients
  - ME value equal to corn
  - Light, golden color is correlated with higher lysine digestibility
  - Phosphorus is ~ 90% available in DDGS compared to 14% availability in corn
- Economical partial replacement for:
  - corn
  - soybean meal
  - dicalcium phosphate
- Increasing production and supply
- Unique properties
  - reduce P excretion in manure
  - increase litter size weaned/sow
  - gut health benefits

Averages, Coefficients of Variation, and Ranges of Selected Nutrients Among 32 U.S. DDGS Sources (100% Dry Matter Basis)

Nutrient	Average	Range
Dry matter, %	89.3	87.3 – 92.4
Crude protein, %	30.9 (4.7)	28.7 – 32.9
Crude fat, %	10.7 (16.4)	8.8 – 12.4
Crude fiber, %	7.2 (18.0)	5.4 – 10.4
Ash, %	6.0 (26.6)	3.0 – 9.8
Swine ME, kcal/kg	3810 (3.5)	3504 – 4048
Lysine, %	0.90 (11.4)	0.61 – 1.06
Phosphorus, %	0.75 (19.4)	0.42 – 0.99

Comparison of Nutrient Composition of Golden DDGS to Other "DDGS Sources" (100% Dry Matter Basis)



	Golden Corn DDGS	"DDGS"	High Fat DDGS	Partial De-germed DDGS	Whiskey DDGS	Pelleted DDGS
Protein, %	31.8	29.3	31.6	30.1	29.9	27.0
Fat, %	11.3	3.5	15.3	8.9	8.8	9.00
Crude fiber, %	6.3	7.9	No data	7.8	10.6	15.10
ADF, %	12.4	11.8	17.9	21.0	20.2	No data
Ash, %	6.9	5.3	4.6	7.3	3.7	4.28
DE, kcal/kg*	4053	3808	No data	3796	No data	No data
ME, kcal/kg*	3781	3577	No data	3560	3789	No data
Lys, %	0.92	0.61	0.90	0.83	0.99	No data
Met, %	0.62	0.54	0.54	0.66	0.61	No data
Thr, %	1.17	1.01	1.04	1.13	1.10	No data
Trp, %	0.25	0.18	0.23	0.25	0.27	No data
Ca, %	0.07	0.12	0.06	0.51	0.04	0.17
P, %	0.77	0.78	0.89	0.68	0.57	0.62

*Calculated energy values for swine

Comparison of Swine DE and ME Estimates of DDGS (88% DM basis)

	DE, Mcal/kg	ME, Mcal/kg	NE, Mcal/kg
U of M – High Quality DDGS (1999)	3.49	3.37	No data
U of M – Traditional DDGS (1999)[1]	3.41	3.10	No data
KSU – High Quality DDGS (2004)[2]	3.87	3.49 – 3.70	2.61
KSU – (2004)[3]	3.73	3.13 – 3.59	2.45
Hanor-Hubbard-Ajinomoto (2004)[4]	No data	3.25	2.42
NRC (1998)	3.45	2.67	No data

[1] Calculated values
[2] Determined by growth and metabolism trials (source Dakota Gold)
[3] **Not DDGS** but corn gluten from a NE ethanol plant
[4] Determined by growth trials (source Dakota Gold)

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

	High Quality U.S. DDGS	DDGS (NRC, 1998)
Lysine, %	0.75 (17.3)	0.59
Methionine, %	0.63 (13.6)	0.48
Threonine, %	0.99 (6.4)	0.89
Tryptophan, %	0.22 (6.7)	0.24
Valine, %	1.32 (7.2)	1.23
Arginine, %	1.06 (9.1)	1.07
Histidine, %	0.67 (7.8)	0.65
Leucine, %	3.12 (6.4)	2.43
Isoleucine, %	0.99 (8.7)	0.98
Phenylalanine, %	1.29 (6.6)	1.27

Values in ( ) are CV's among plants

Standardized Ileal Lysine Digestibility Coefficients Among 8 "Golden" Corn DDGS Sources (Urriola et al., 2006 unpublished)

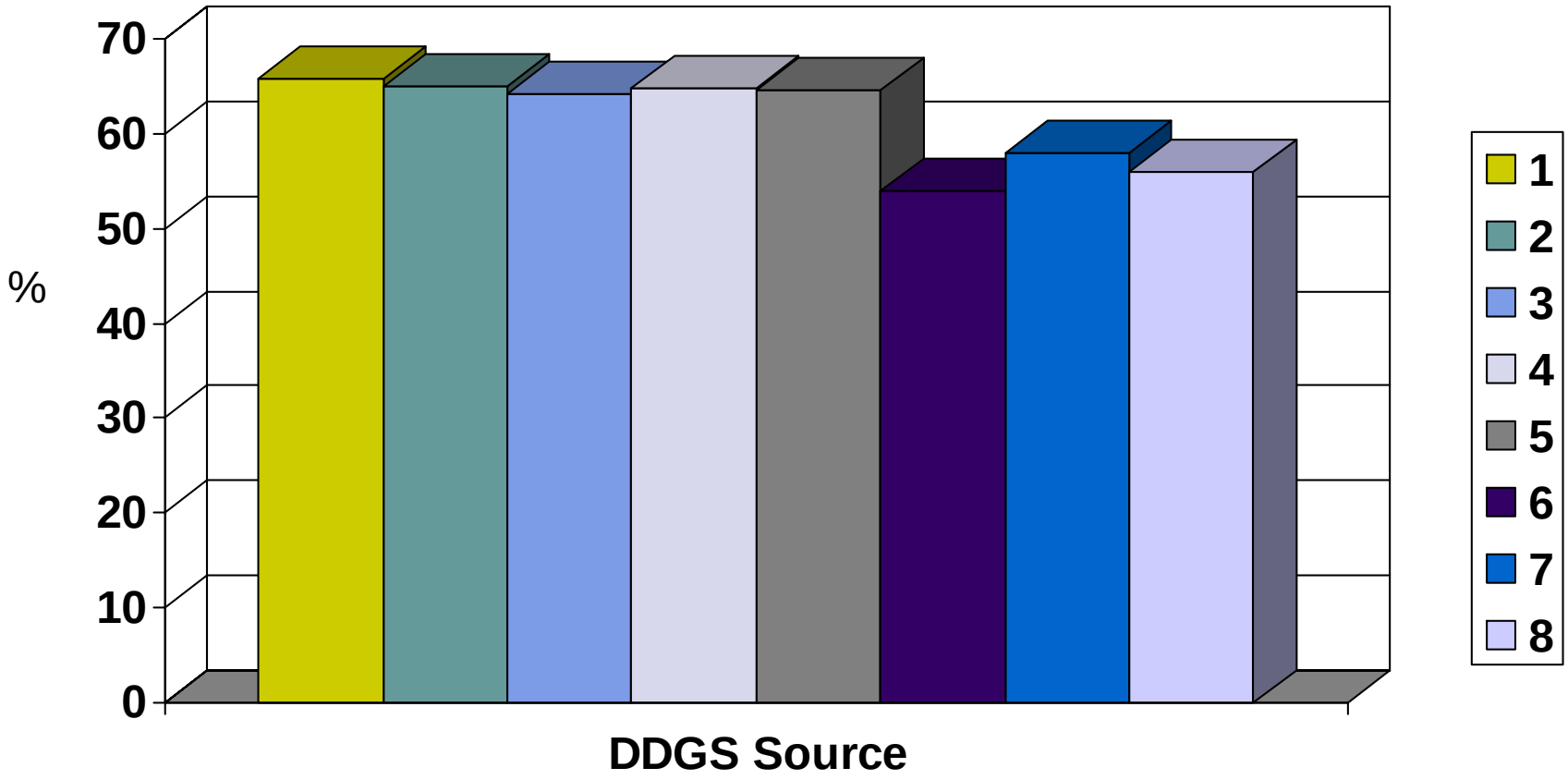
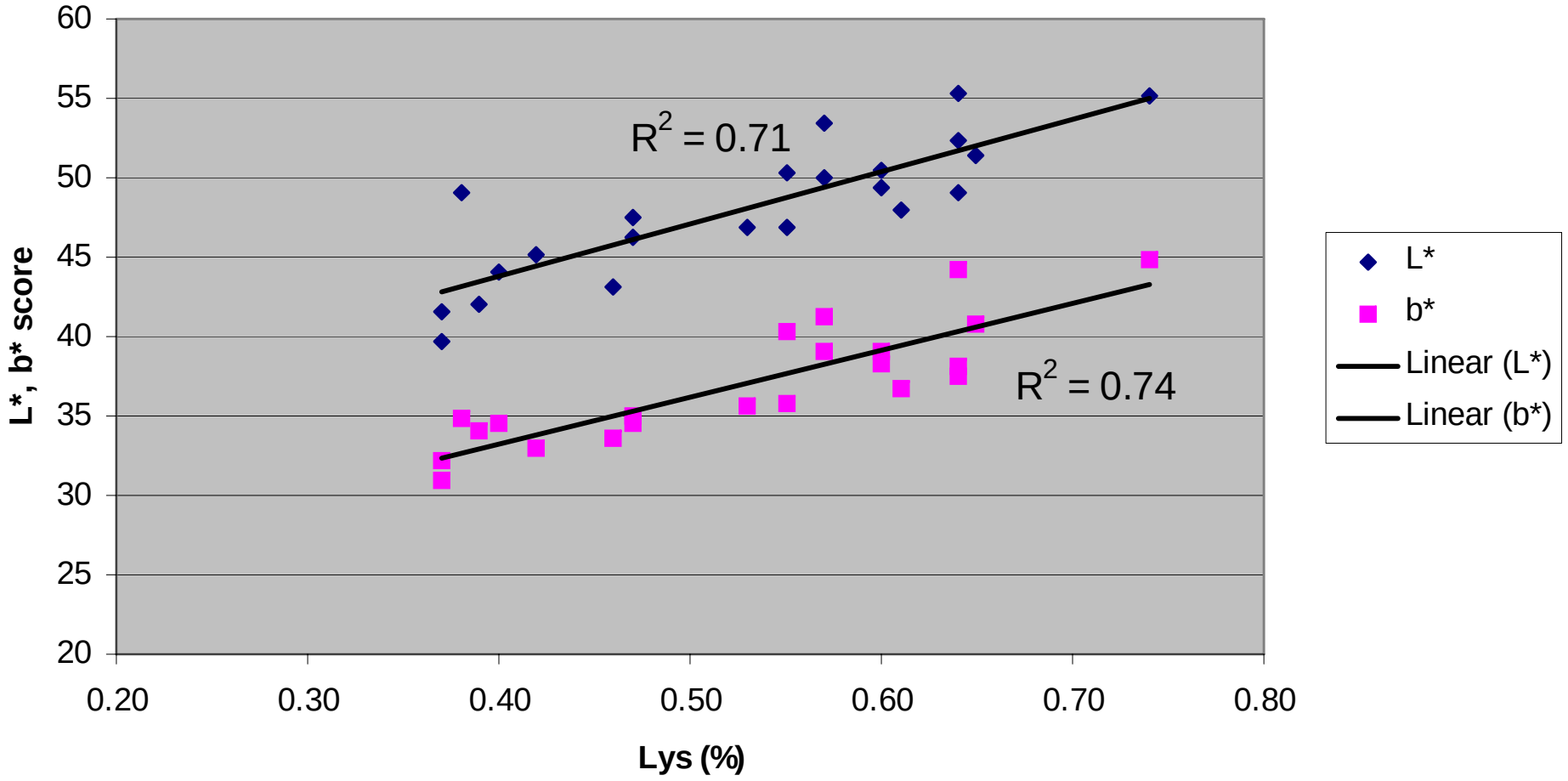
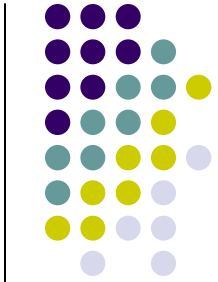


Fig. 1. Regression of digestible lys (%) and color (L*, b*)



Source: Dr. Sally Noll (2003)

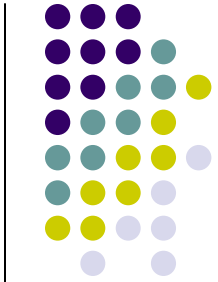
Comparison of Phosphorus Level and Relative Availability of DDGS for Swine (88% dry matter basis)



	High Quality DDGS	Traditional 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

Maximum Inclusion Rates of Golden High Quality U.S DDGS in Swine Diets

(Based Upon University of Minnesota Performance Trials)

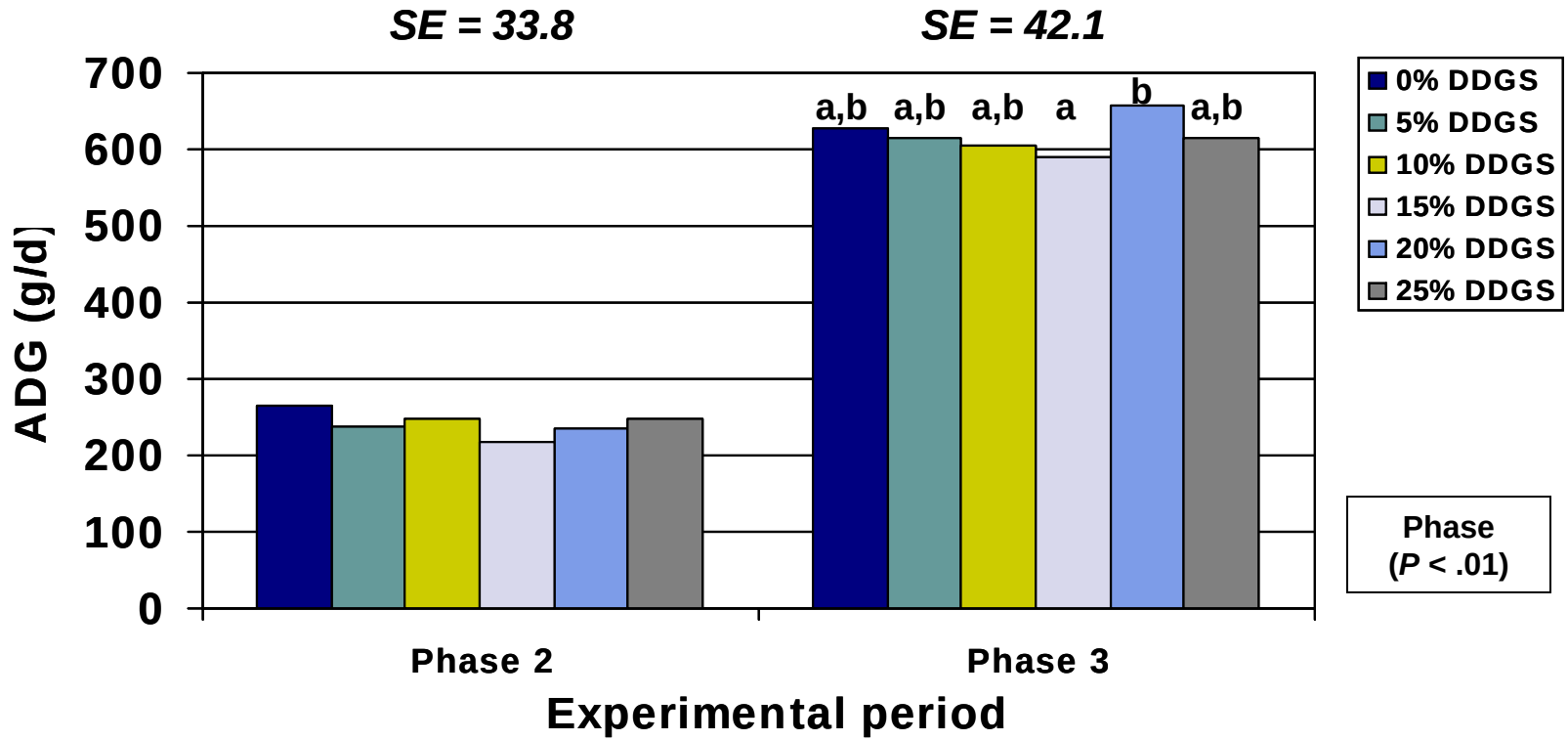


- Nursery pigs (> 7 kg)
  - Up to 25 %
- Grow-finish pigs
  - Up to 20% (higher levels may reduce pork fat quality)
- Gestating sows
  - Up to 50%
- Lactating sows
  - Up to 20%

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

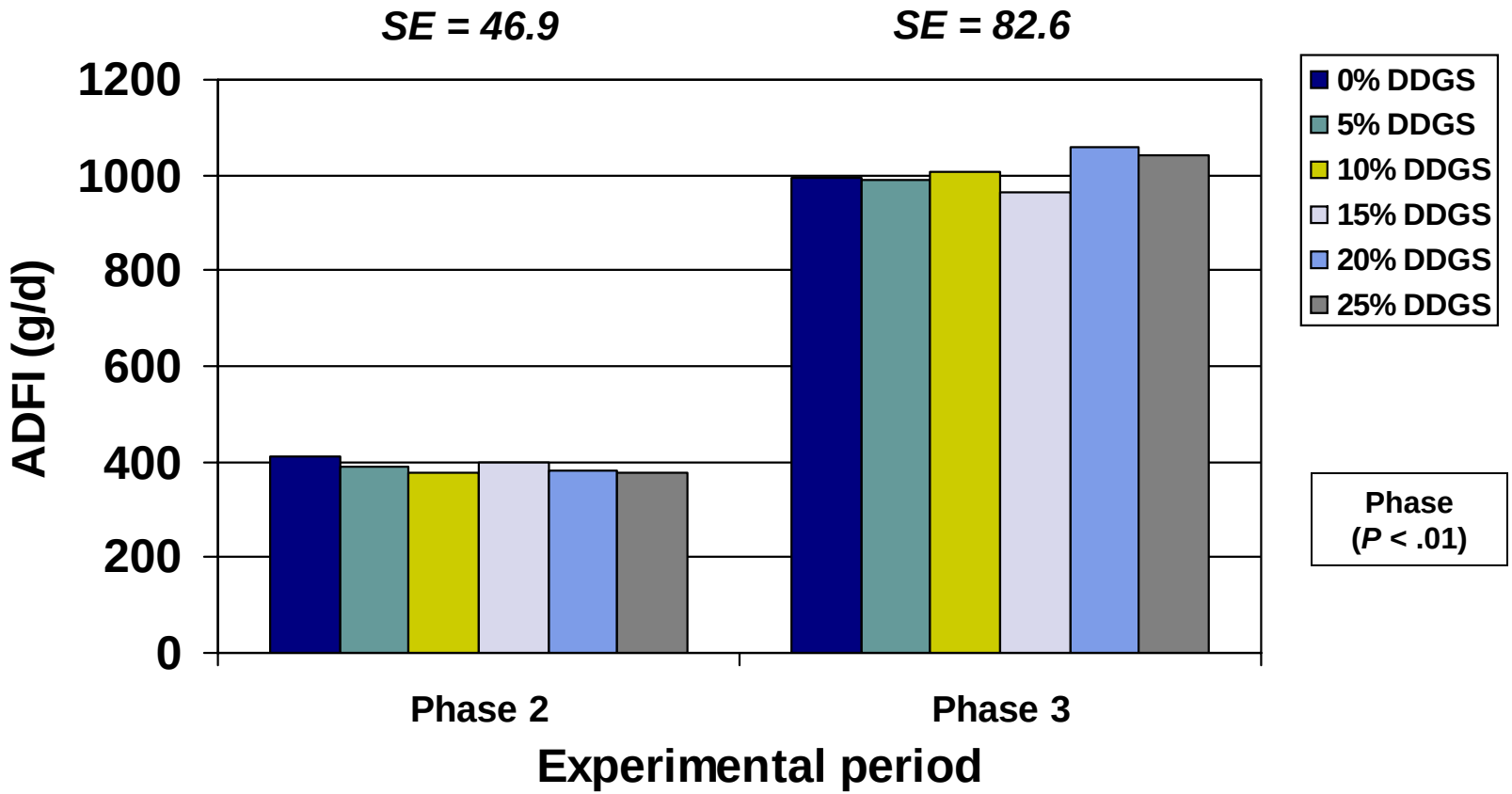
Feeding High Quality DDGS to Weaned Pigs

Effect of DDGS Level on Growth Rate (Experiment 1)

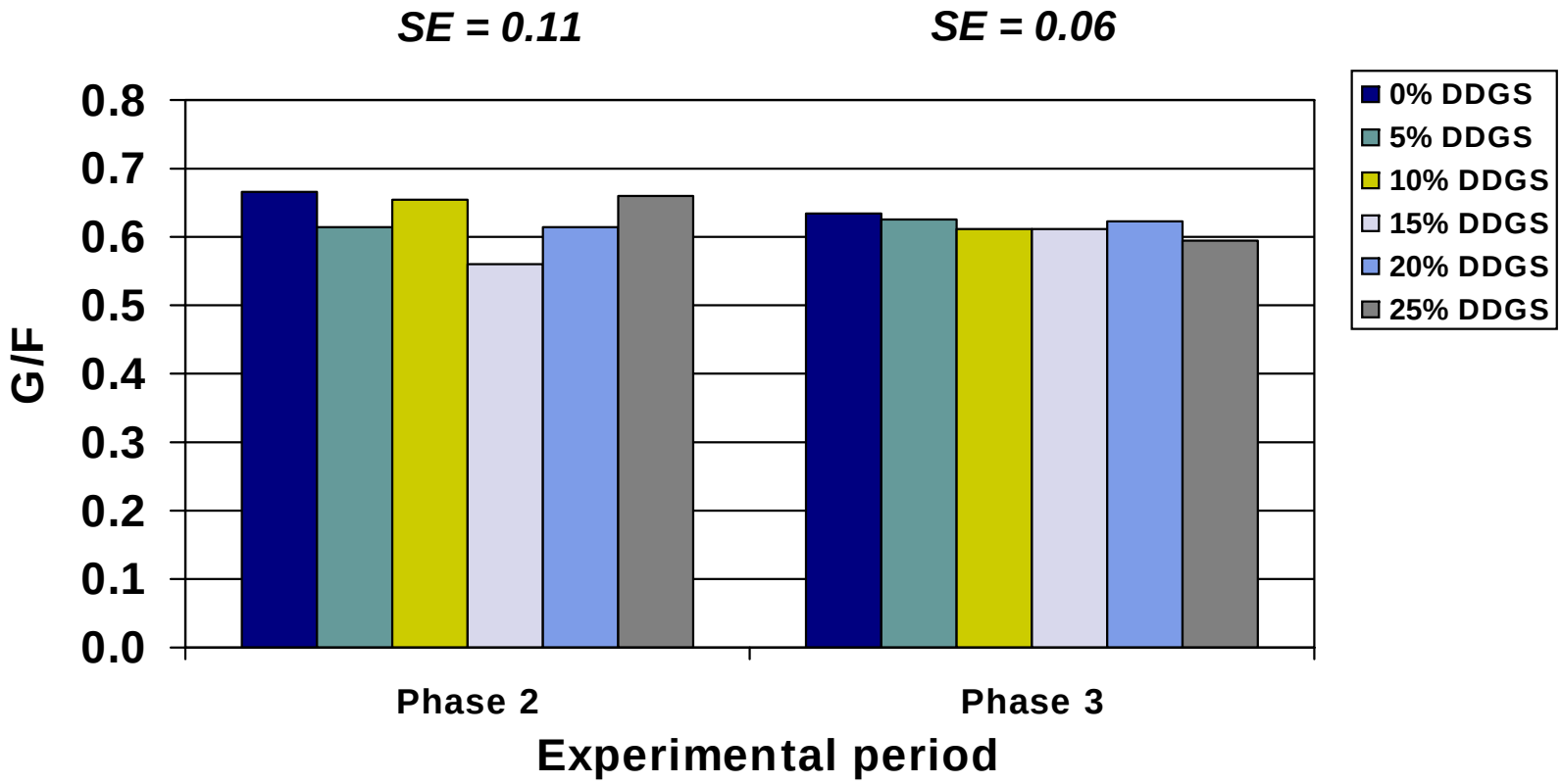


Means not sharing a common superscript letter are significantly different ($P < .05$)

Effect of DDGS Level on Average Daily Feed Intake (Experiment 1)

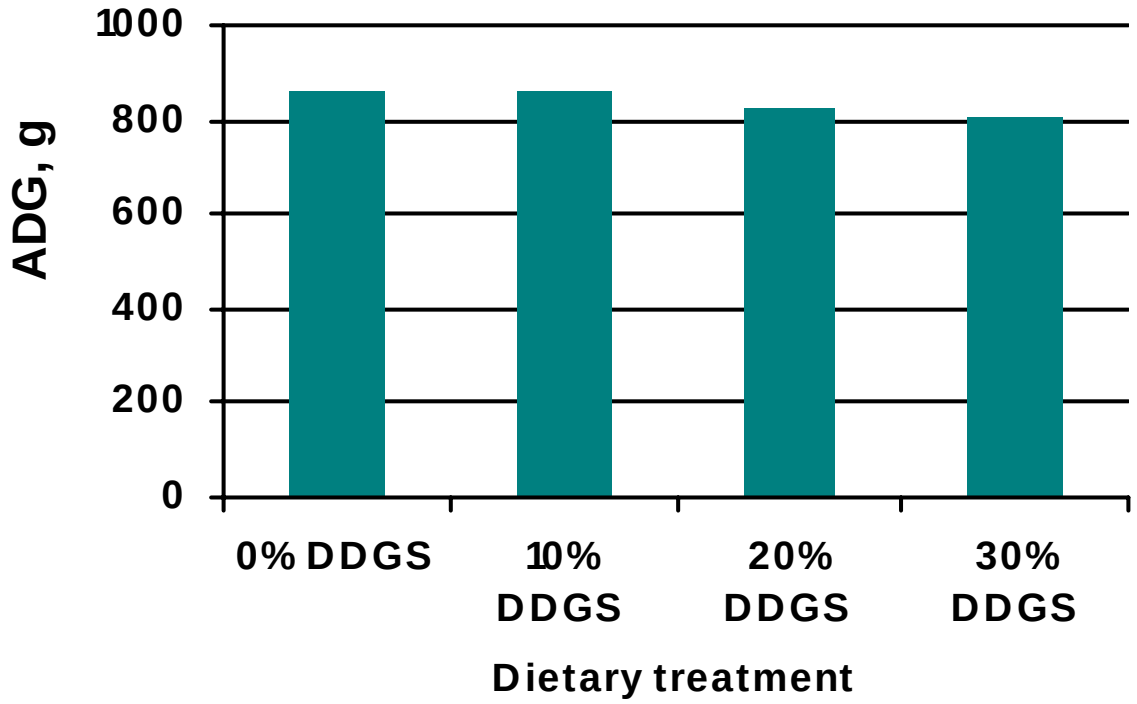


Effect of DDGS Level on Gain/Feed (Experiment 1)



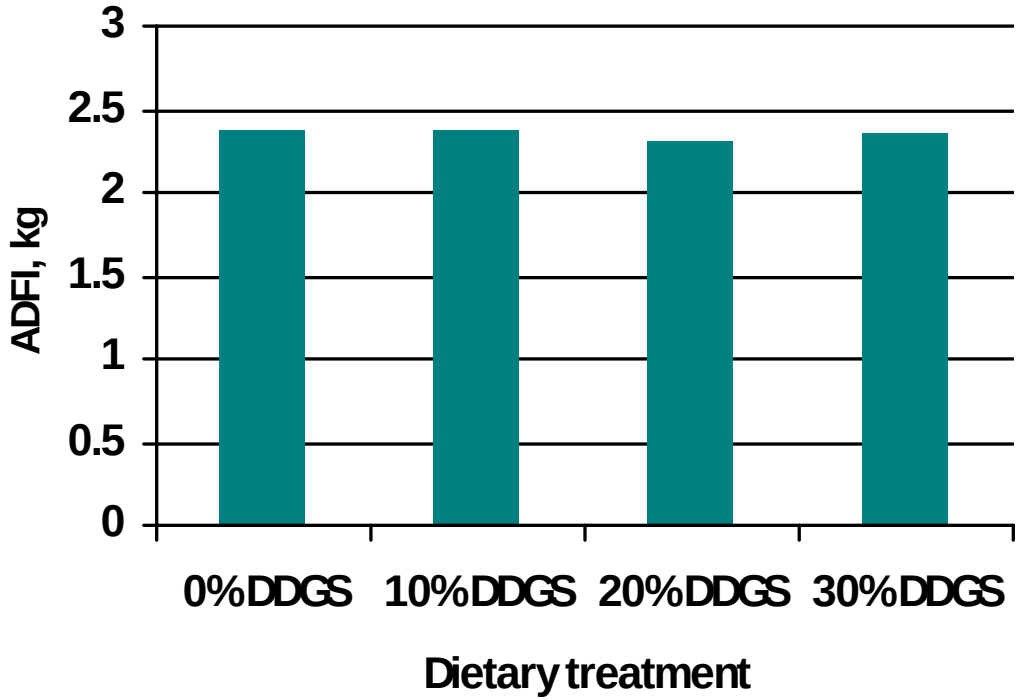
Feeding High Quality DDGS to Grow-Finish Pigs

Effect of Dietary DDGS Level on Overall ADG of Grow-Finish Pigs



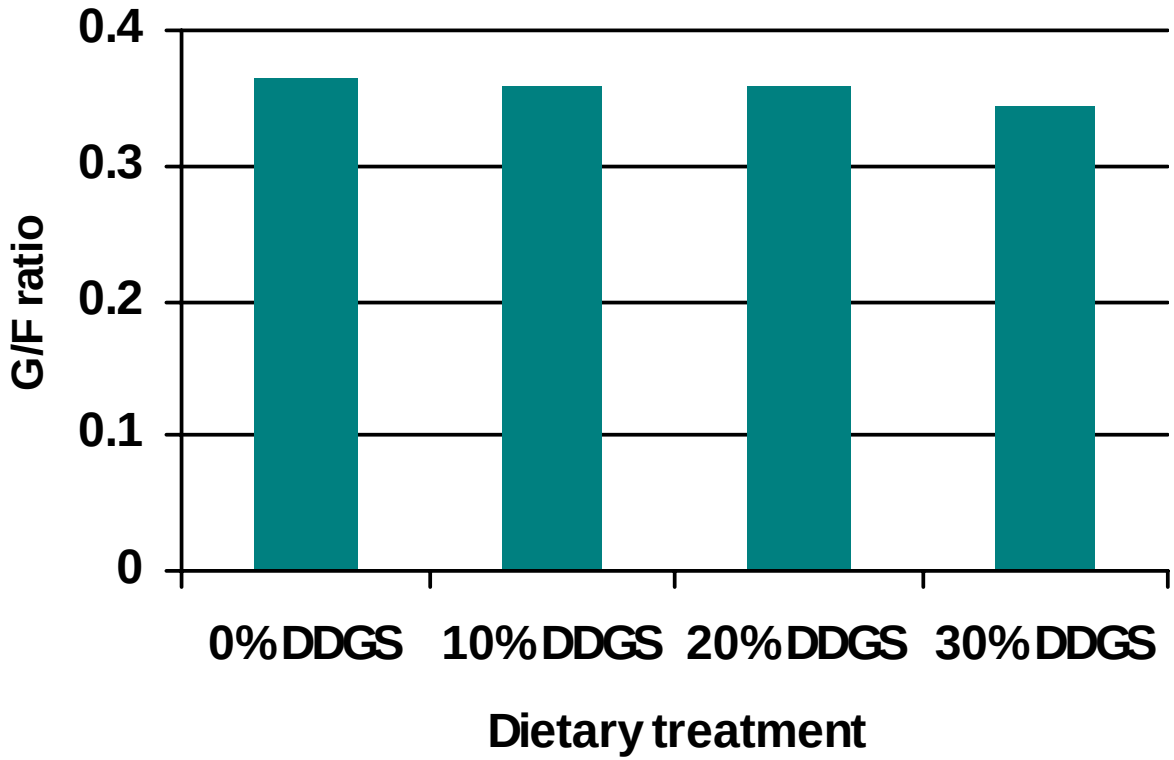
0 % and 10 % DDGS > 20% and 30% DDGS (P < .10)

Effect of Dietary DDGS Level on Overall ADFI of Grow-Finish Pigs



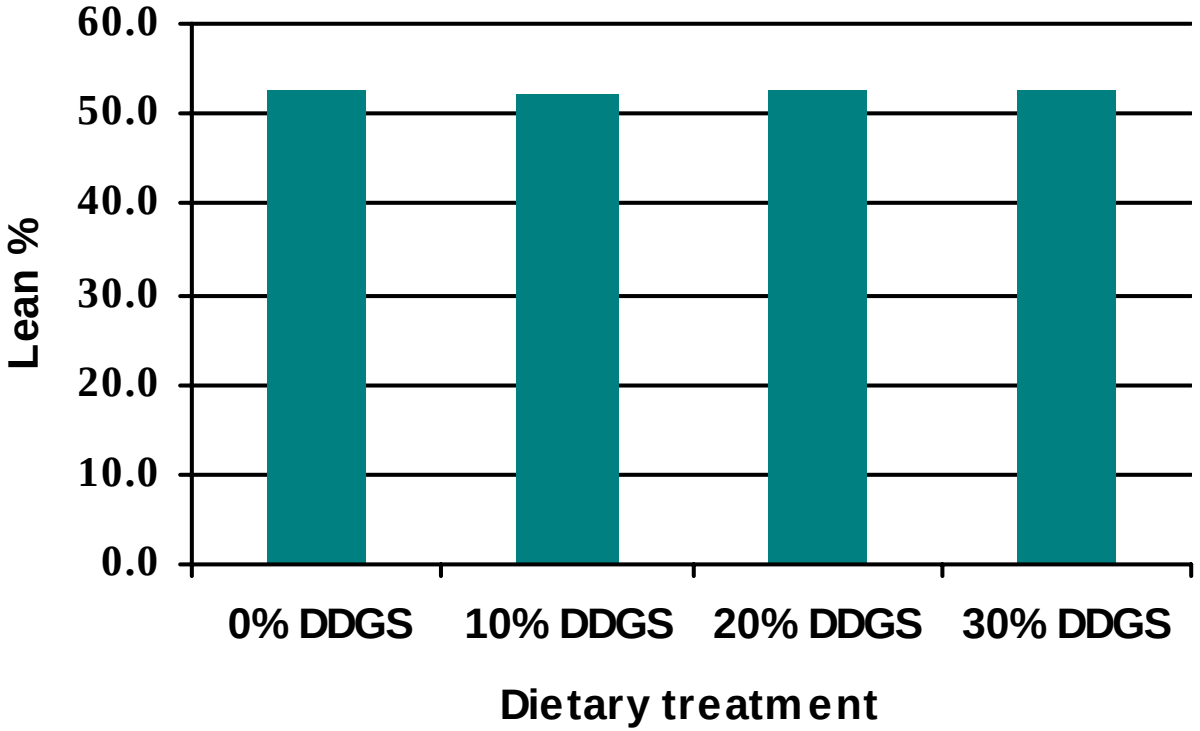
No significant differences among dietary treatments

Effect of Dietary DDGS Level on Overall G/F of Grow-Finish Pigs



0 %, 10 % and 20% DDGS > 30% DDGS (P < .10)

Effect of Dietary DDGS Level on % Carcass Lean



No significant differences among dietary treatments

Muscle Quality Characteristics from Grow-Finish Pigs Fed Diets Containing 0, 10, 20, and 30% DDGS

Trait	0 %	10 %	20 %	30 %	RMSE
L*[a]	54.3	55.1	55.8	55.5	2.9
Color score[b]	3.2	3.2	3.1	3.1	0.8
Firmness score[c]	2.2	2.0	2.1	2.1	0.5
Marbling score[d]	1.9	1.9	1.7	1.9	0.6
Ultimate pH	5.6	5.6	5.6	5.6	0.2
11-d purge loss, %	2.1[f]	2.4[fg]	2.8[g]	2.5[fg]	1.2
24-h drip loss	0.7	0.7	0.7	0.7	0.2
Cooking loss, %	18.7	18.5	18.3	18.8	2.6
Total moisture loss[e], %	21.4	21.5	21.8	22.1	3.1
Warner-Bratzler sheer force, kg	3.4	3.4	3.3	3.3	0.5

[a] 0 = black, 100 = white
[b] 1=pale pinkish gray/white; 2=grayish pink; 3=reddish pink; 4=dark reddish pink; 5=purplish red; 6=dark purplish red
[c] 1 = soft, 2 = firm, 3 = very firm
[d] Visual scale approximates % intramuscular fat content (NPPC, 1999)
[e] Total moisture loss = 11-d purge loss + 24-h drip loss + cooking loss

Fat Quality Characteristics of Market Pigs Fed Corn-Soy Diets Containing 0, 10, 20, and 30% DDGS

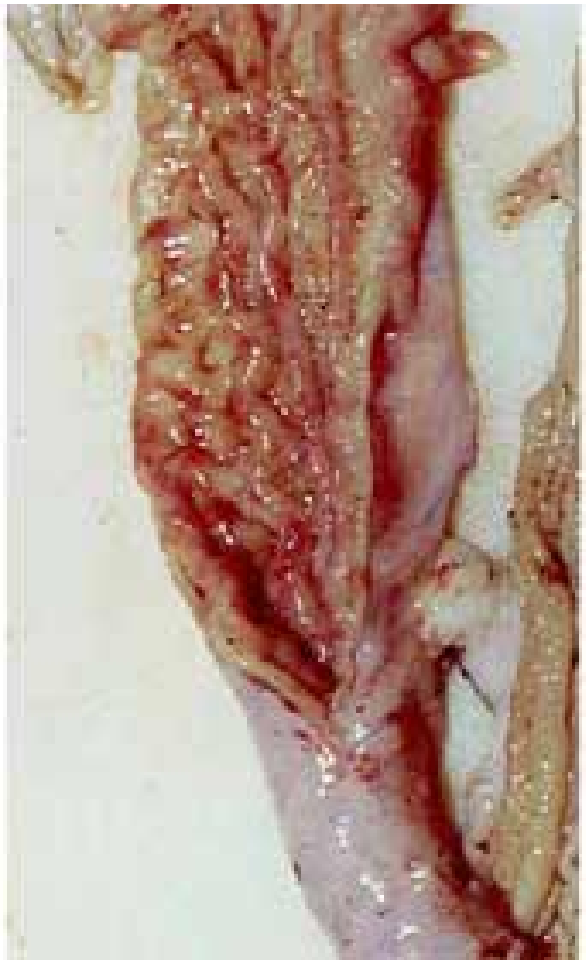
	0 %	10%	20%	30%
Belly thickness, cm	3.15[a]	3.00[a,b]	2.84[a,b]	2.71[b]
Belly firmness score, degrees	27.3[a]	24.4[a,b]	25.1[a,b]	21.3[b]
Adjusted belly firmness score, degrees	25.9[a]	23.8[a,b]	25.4[a,b]	22.4[b]
Iodine number	66.8[a]	68.6[b]	70.6[c]	72.0[c]

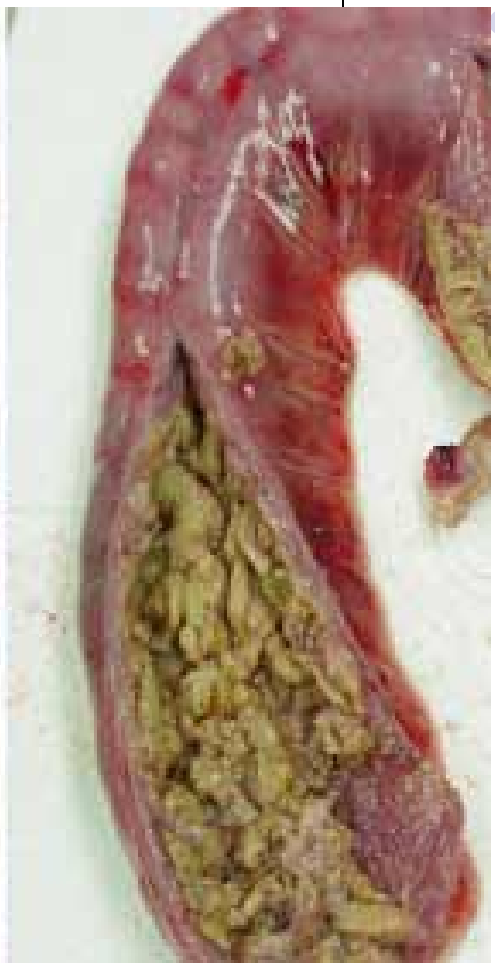
Means within a row lacking common superscripts differ (P < .05).

Does Feeding DDGS Improve Gut Health of Growing Pigs?

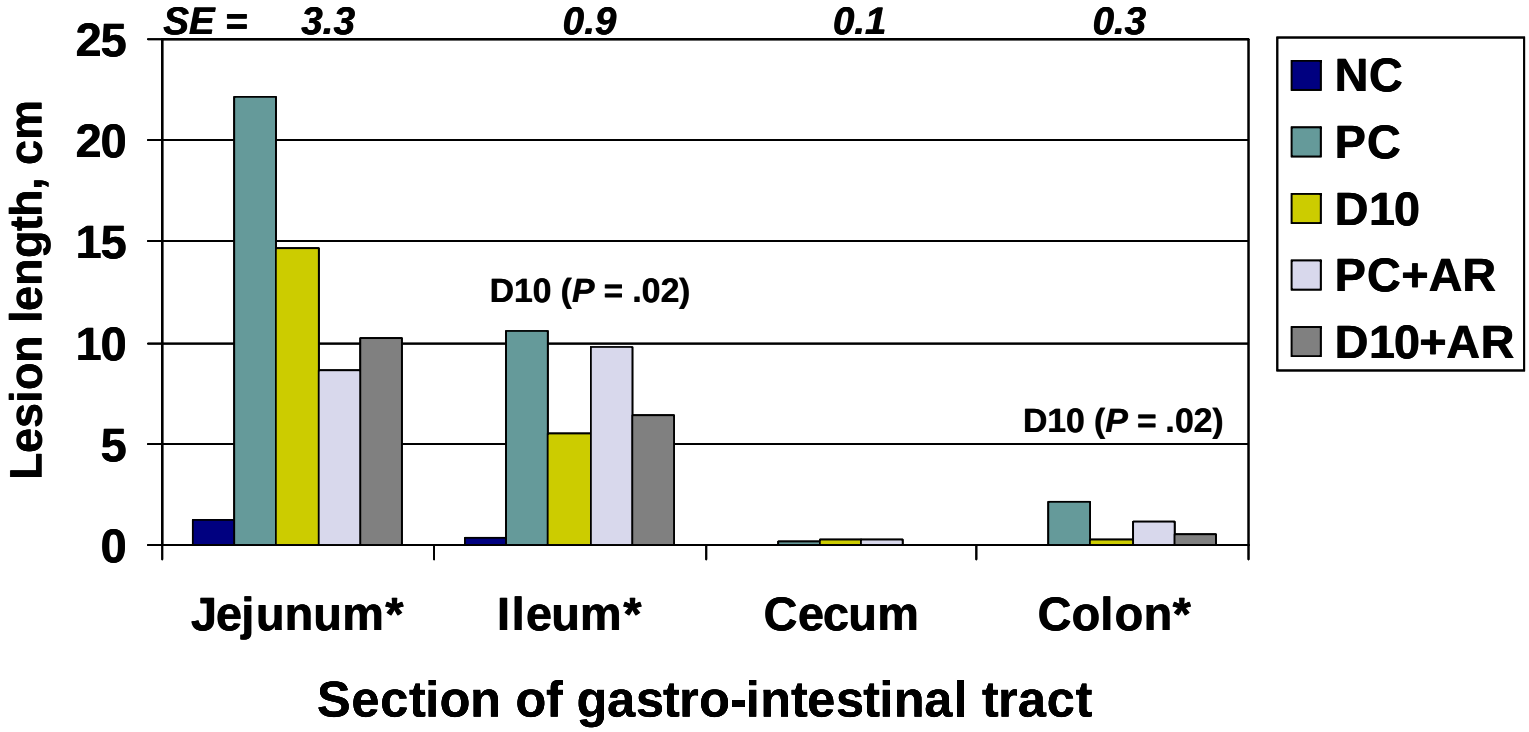
Healthy

Ileitis



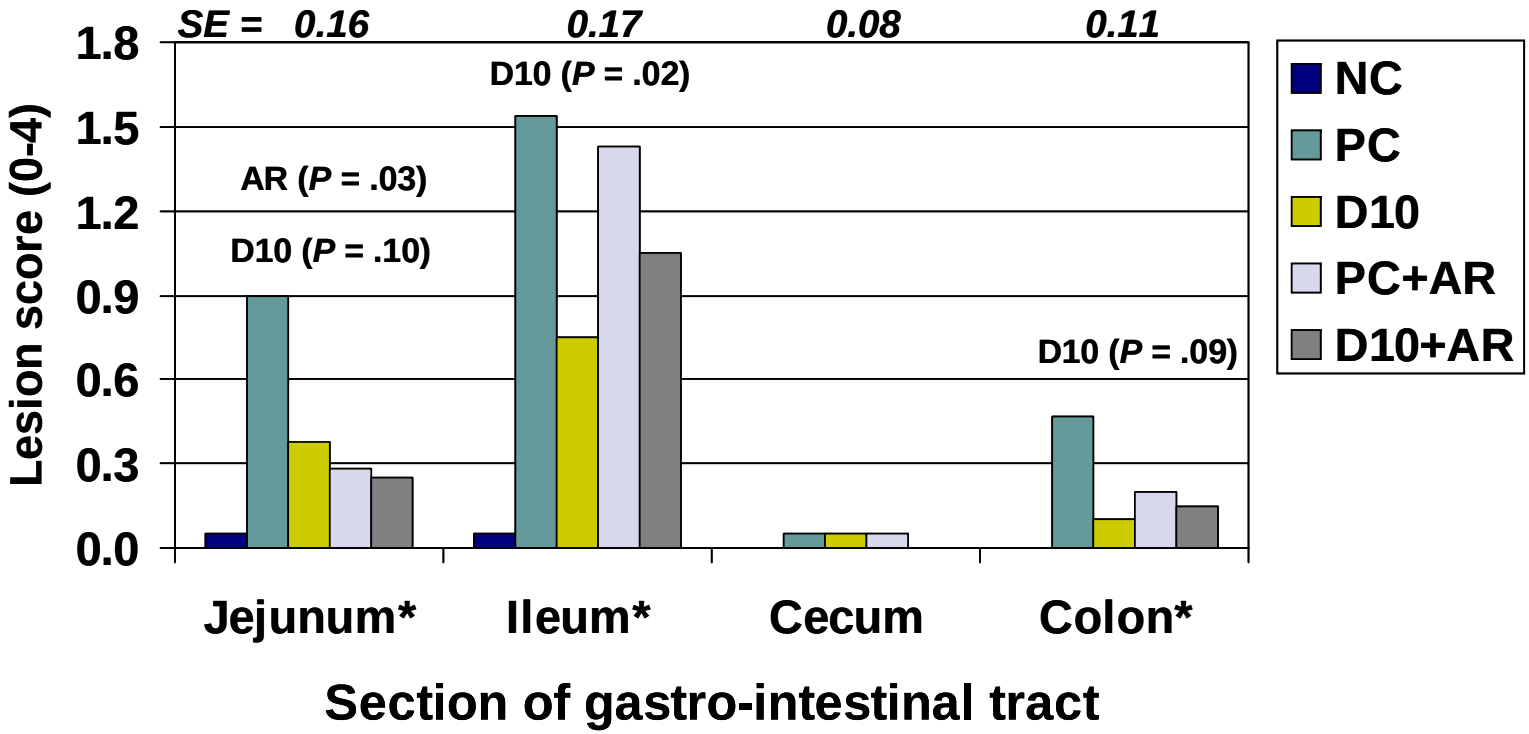


Effect of Dietary Treatment on Lesion Length (21 d Post-Challenge)



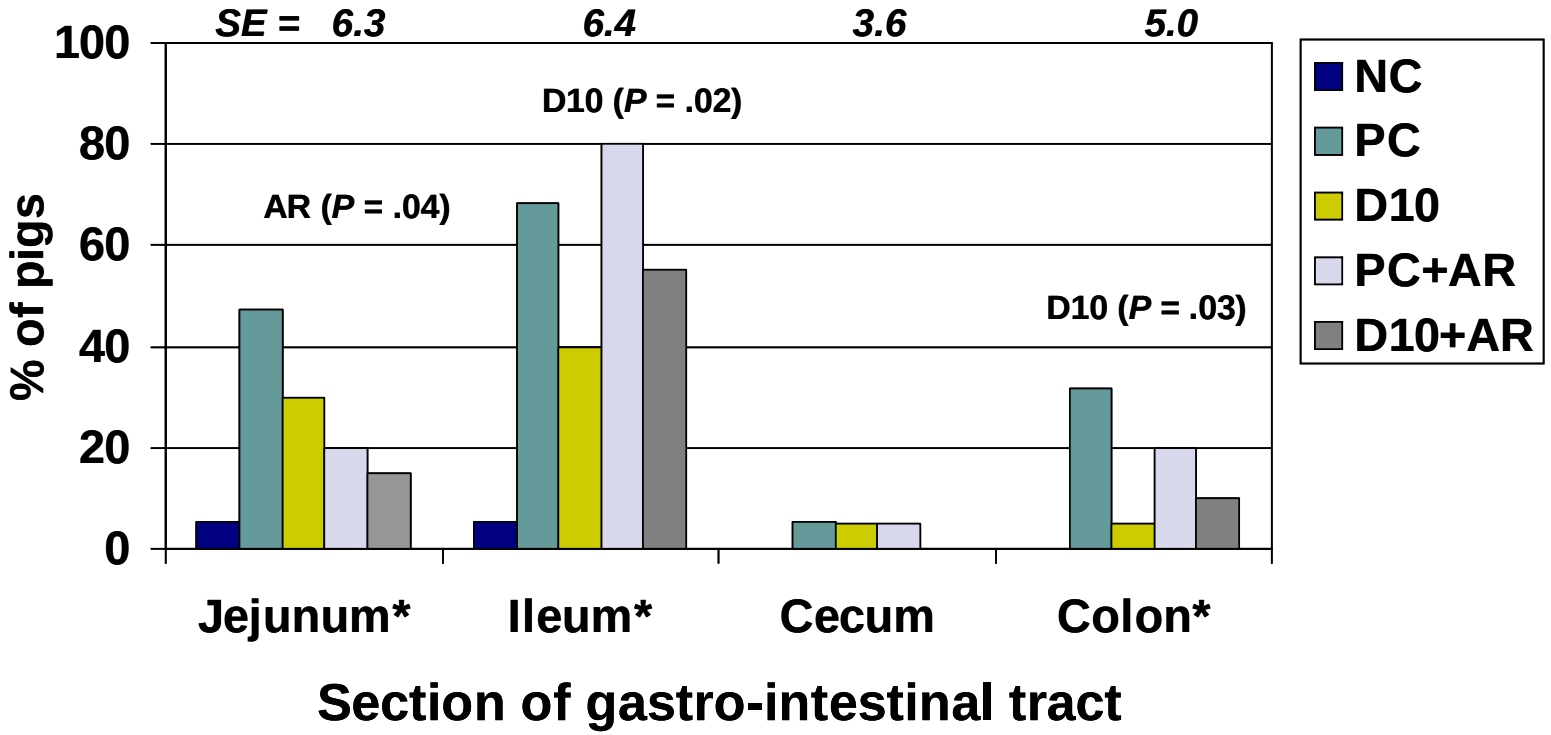
* Effect of disease challenge ($P < .01$).

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



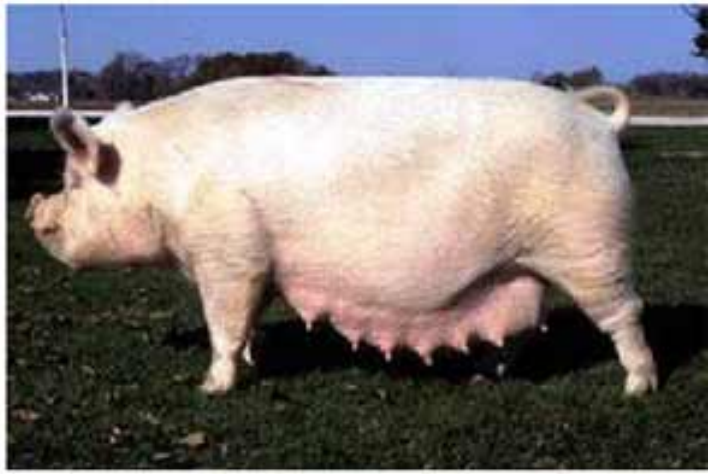
* Effect of disease challenge ($P < .01$).

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

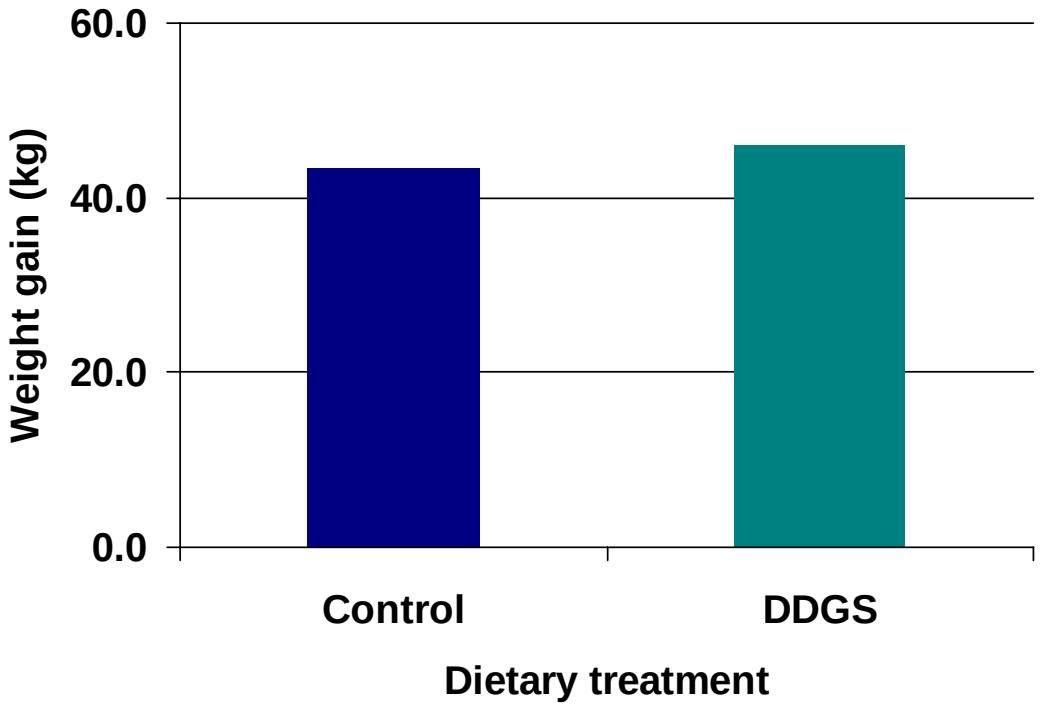


* Effect of disease challenge ($P < .01$).

Feeding High Quality DDGS to Sows

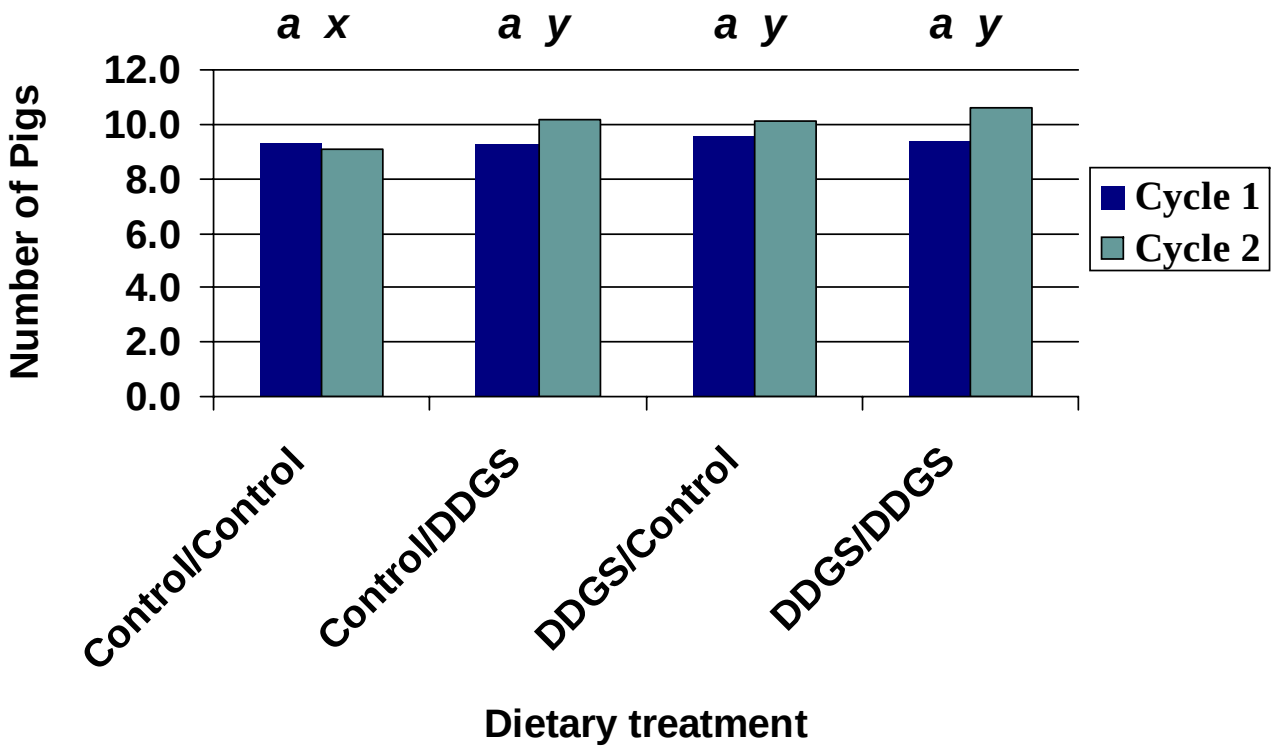


Effect of Feeding a 50% DDGS Diet on Sow Weight Gain During Gestation (Reproductive Cycle 1)



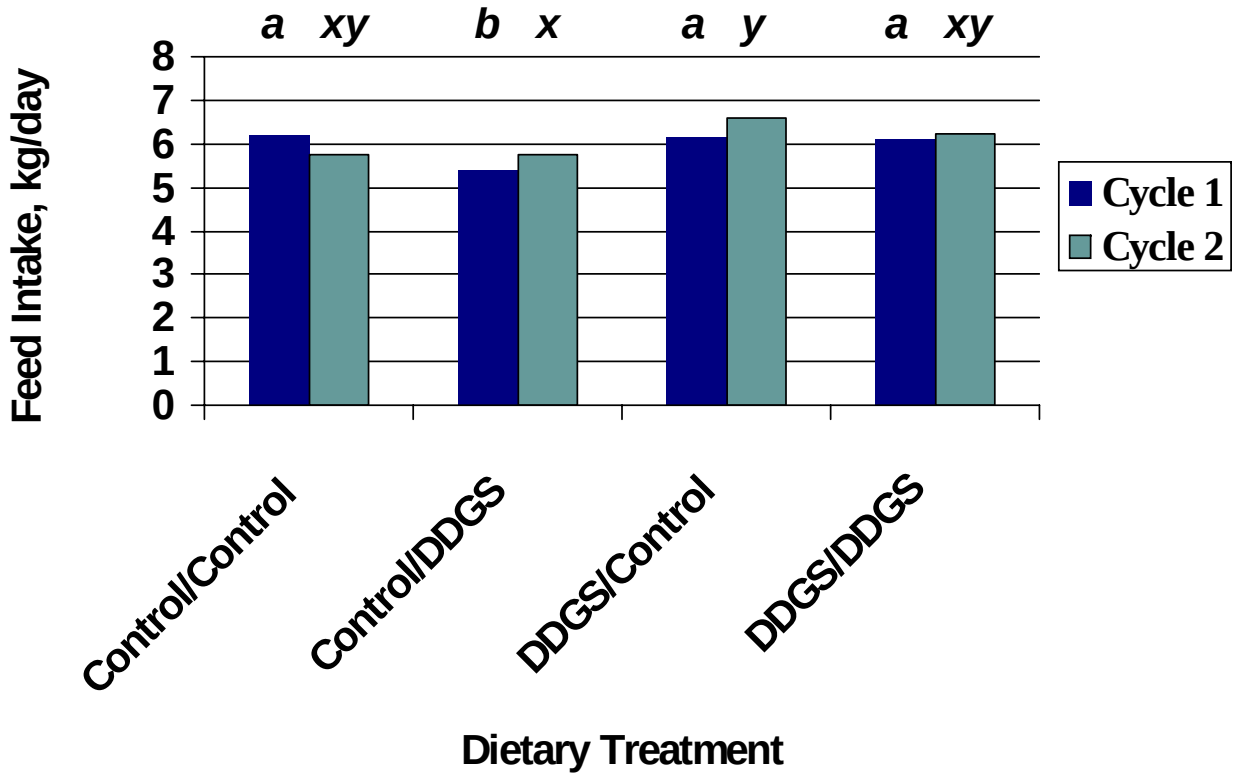
(P > .22)
MSE 10.12

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



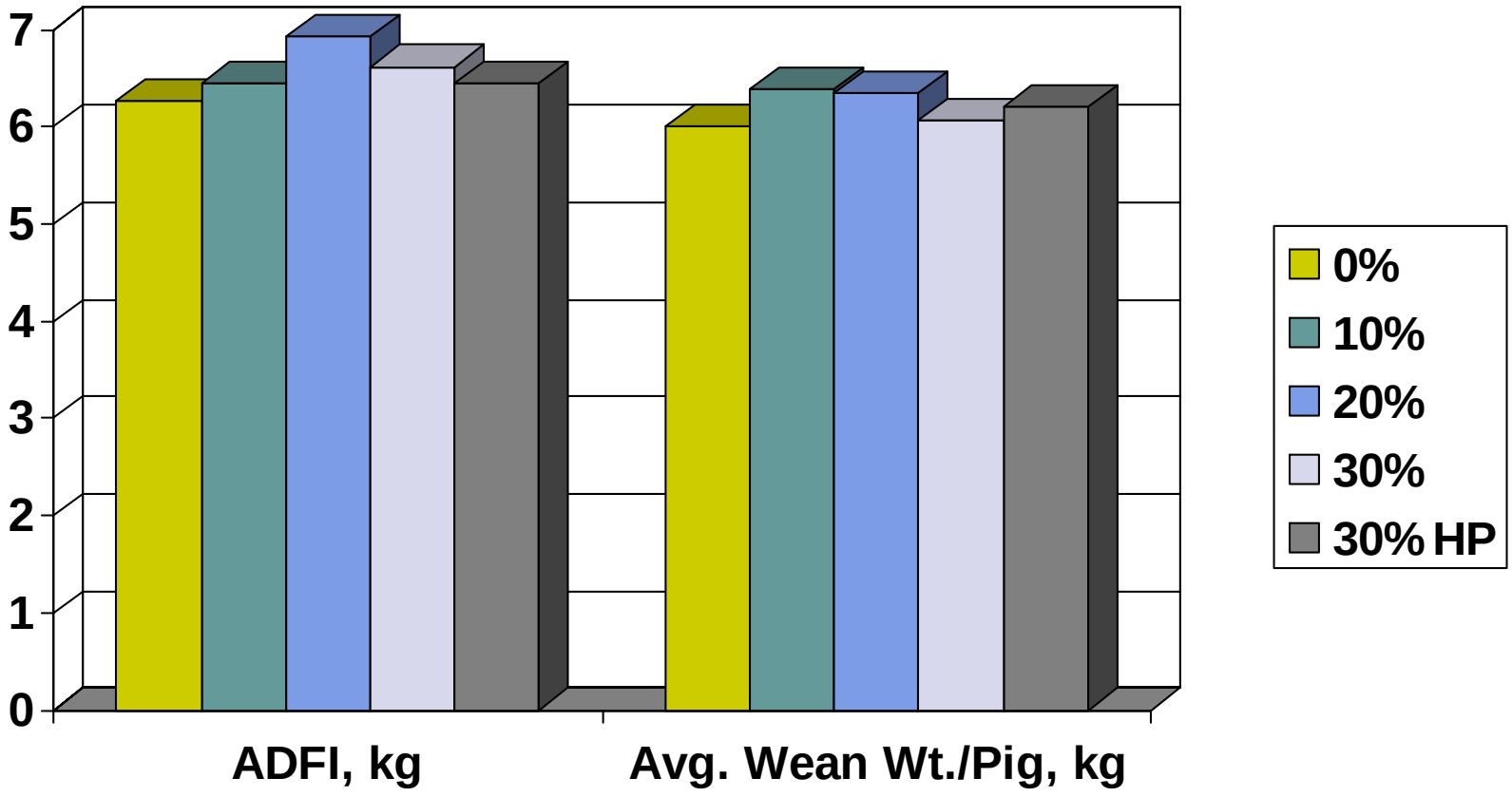
[a,b,x,y] Different superscripts indicate significant difference (P < .10).

Effect of Dietary Treatment Combination on Sow Lactation ADFI



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

Effects of Feeding Increasing Levels of DDGS to Lactating Sows on Average Daily Feed Intake and Average Pig Weight at Weaning (Song et al., 2006)

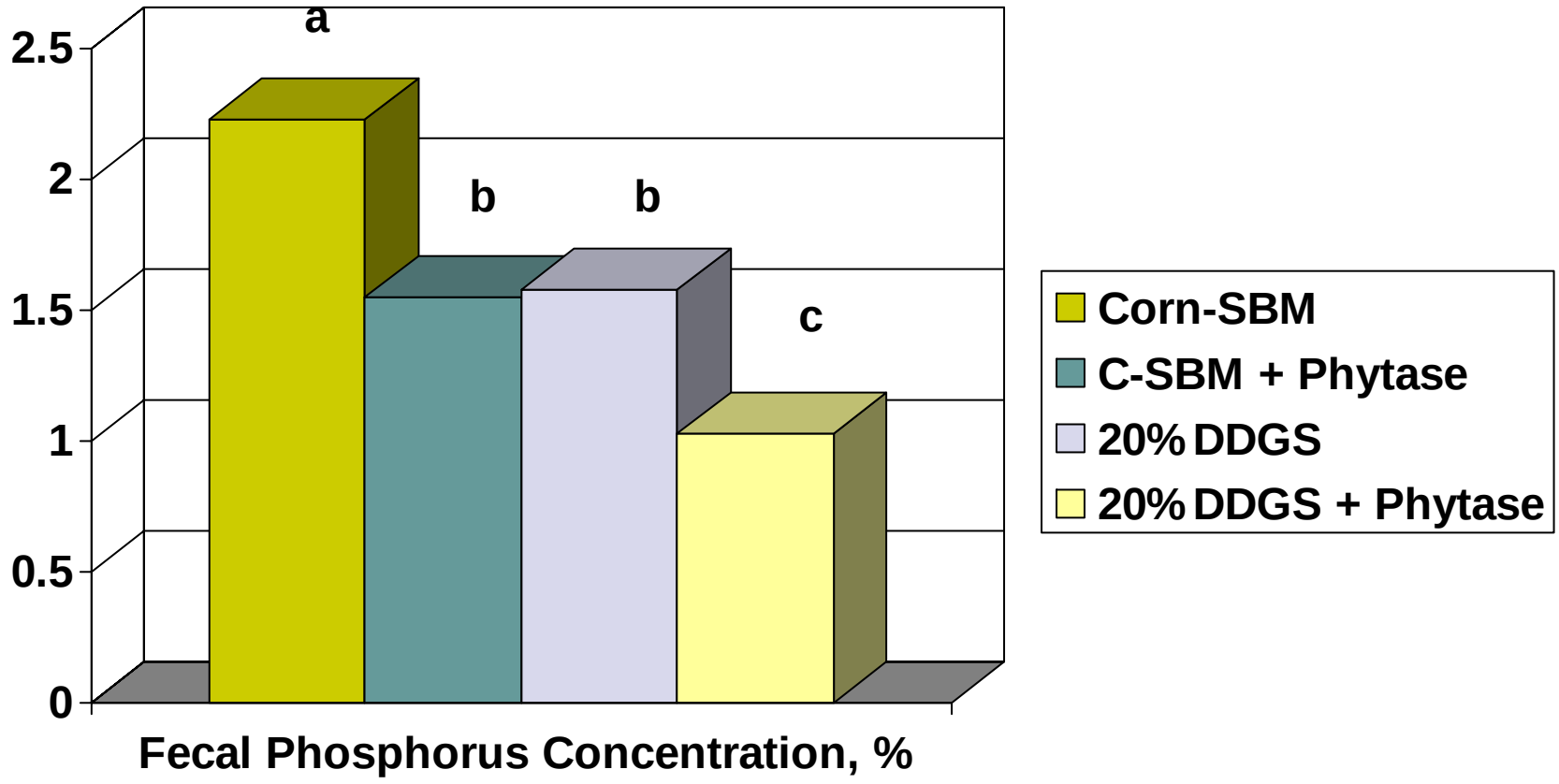


Utilized 323 lactating sows (65 sows/dietary treatment)

Diet Composition When 18.8% DDGS and Phytase are Added to a Swine Grower Diet

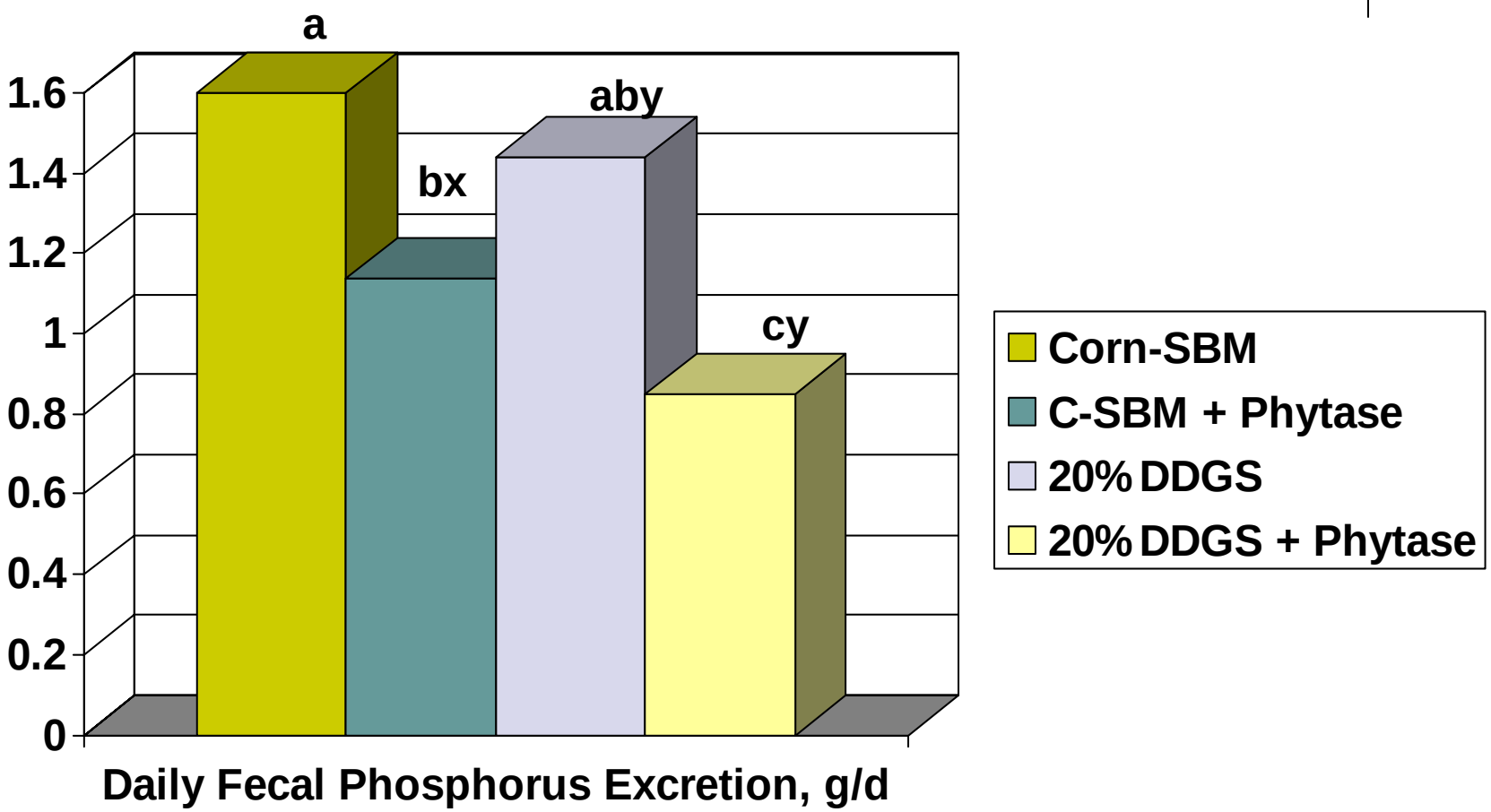
Ingredient	Corn-SBM-1.5 kg Lysine	18.8% DDGS + Phytase
Corn, kg	798.3	636.3
Soybean meal 44%, kg	176.9	159.4
DDGS, kg	0.0	188
Dicalcium phosphate, kg	11.6	0.0
Limestone, kg	7.2	9.8
Salt, kg	3.0	3.0
L-lysine HCl, kg	1.5	1.5
VTM premix, kg	1.5	1.5
Phytase, 500 FTU/kg	0.0	0.5
TOTAL, kg	1000.0	1000.0

Effect of Feeding Corn-SBM Diets With or Without 20% DDGS or Phytase on Fecal Phosphorus Concentration (%)



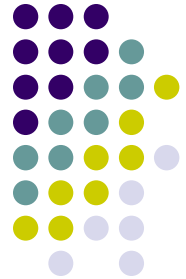
a,b Means with different superscripts are significantly different (P < .05).

Effect of Feeding Corn-SBM Diets With or Without 20% DDGS or Phytase on Daily Fecal Phosphorus Excretion (g/d)



a,b,c Means with different superscripts are significantly different (P < .05).
x,y Means with different superscripts are significantly different (P < .15).

Quick Calculation of Feed Cost Savings



Thumb rule:

Additions/1000 kg diet

+ 100 kg DDGS x _____ $/kg = $_____
+ 1.5 kg limestone x _____ $/kg = $_____
TOTAL ADDITIONS (A) $_____

Subtractions/1000 kg diet

- 88.5 kg corn x _____ $/kg = $_____
- 10 kg SBM (44%) x _____ $/kg = $_____
- 3 kg dical. phos. x _____ $/kg = $_____
TOTAL SUBTRACTIONS (S) $_____

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

Facts About Mycotoxins in DDGS

- Risk of mycotoxins in corn in the upper Midwest of the U.S. is low
  - Exception may be last year's corn crop
    - Many corn piles still outside
    - A few isolated cases of ethanol plants using contaminated corn
- Screening procedures for mycotoxins in corn at ethanol plants
  - range from very aggressive to minimal
- If mycotoxins are present in corn used for ethanol and DDGS production…
  - they will be concentrated 3X in DDGS

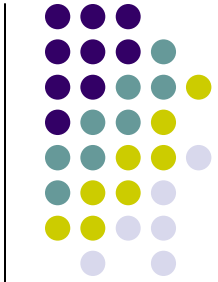
Facts About Mycotoxins in DDGS

- Keep the potential contribution of mycotoxins from DDGS in perspective
  - About 65 to 85% of swine grow-finish diets are comprised of corn
    - If corn contained 1 ppm zearalenone, it would contribute .13 to .17 g/ton of feed
  - Most grow-finish diets contain 10% DDGS
    - If the same corn was used to produce DDGS…
      - the zearalenone level would be 3 ppm
      - the contribution to the total diet would be 0.06 g/ton of feed

Facts About Mycotoxins in DDGS

- When testing for mycotoxins in DDGS, send samples only to laboratories that use HPLC procedures
  - ELISA test kits work well for corn
  - ELISA test kits **DO NOT** work well for detecting mycotoxins in DDGS
    - ELISA gives false, high readings due to interfering compounds that are read as mycotoxins but are actually not during detection

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
* nutrient profiles of DDGS sources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