The Feeding Value of High Quality Corn DDGS to Swine

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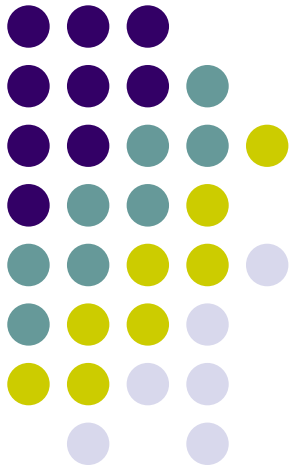
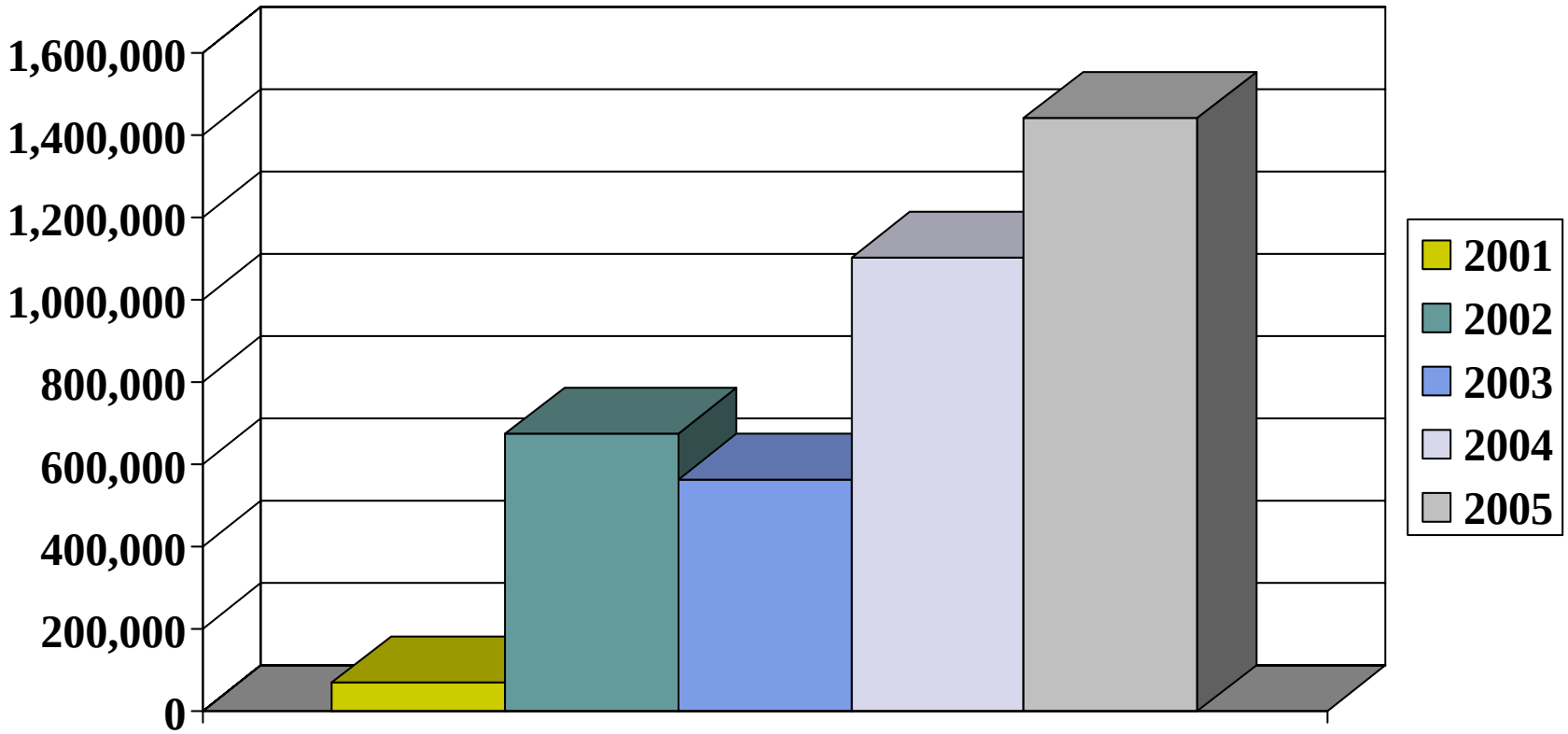


Estimated DDGS Usage in U.S. Swine Feeds 2001-2005 (Metric Tonnes)

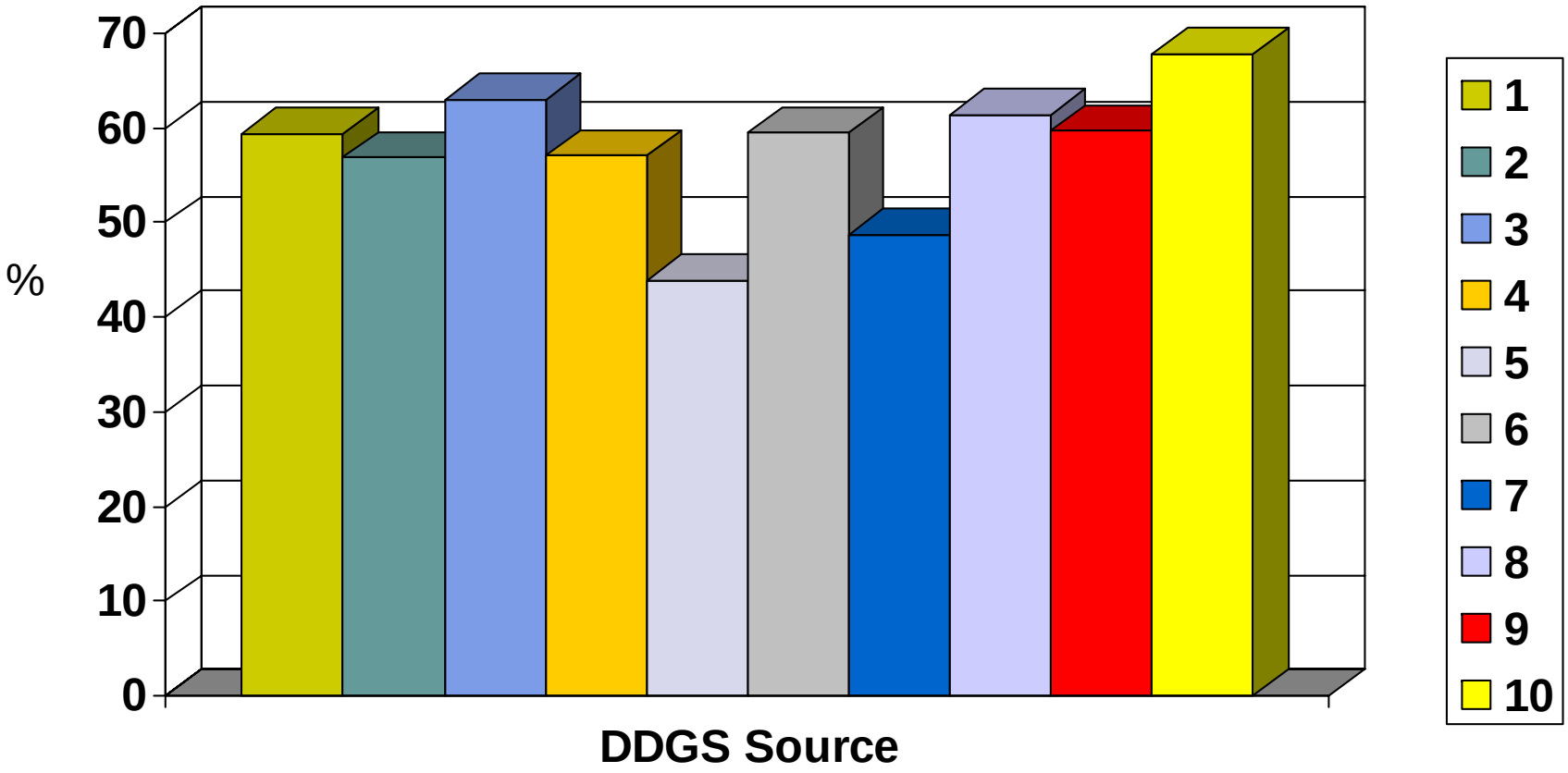


DDGS Varies in Nutrient Content and Digestibility, Color, and Particle Size Among U.S. Sources

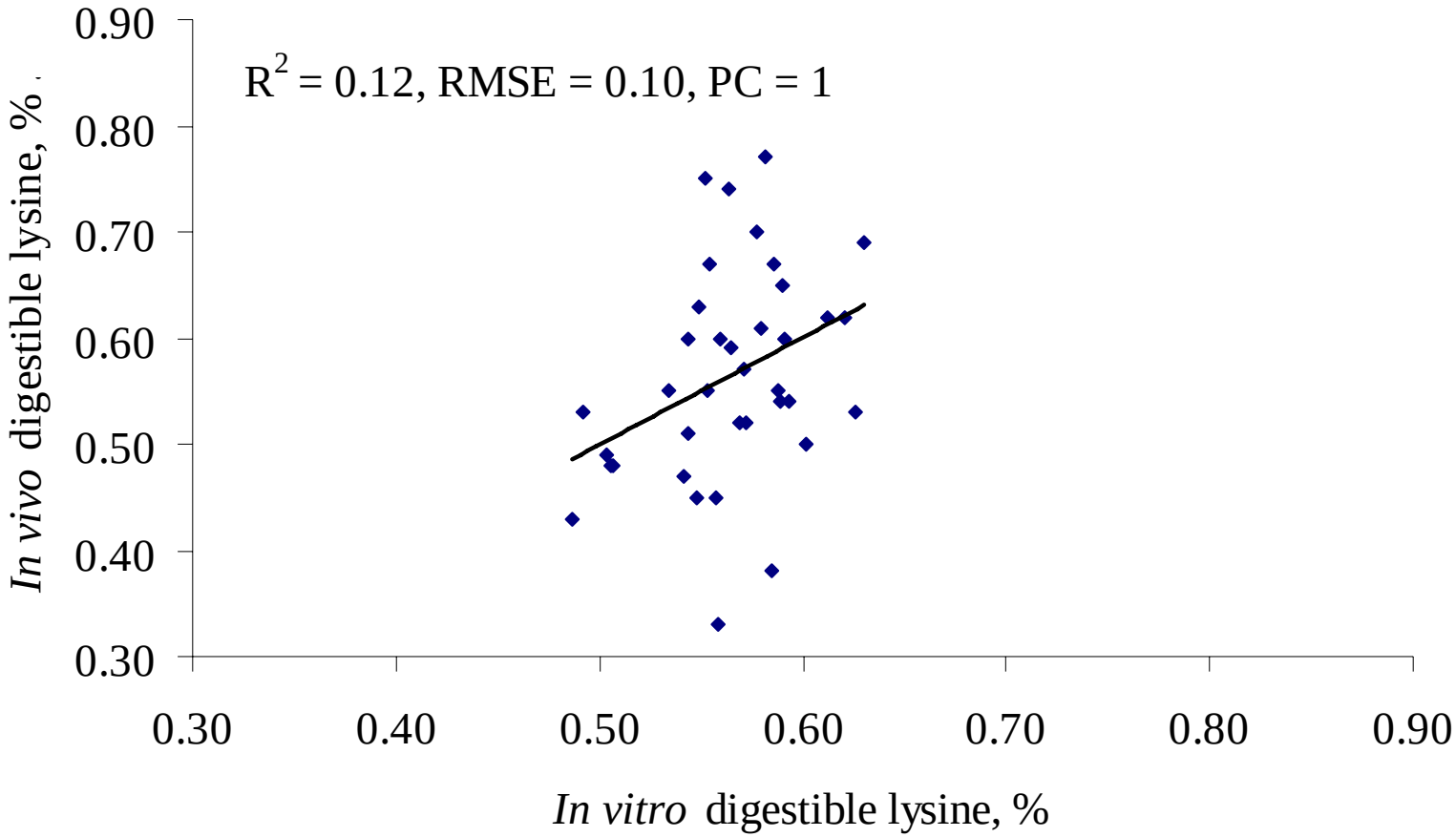
Averages, Coefficients of Variation, and Ranges of Selected Nutrients Among 32 U.S. DDGS Sources (100% Dry Matter Basis)

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

Standardized Ileal Lysine Digestibility Coefficients Among 10 "Golden" Corn DDGS Sources for Swine (Stein et al., 2005)

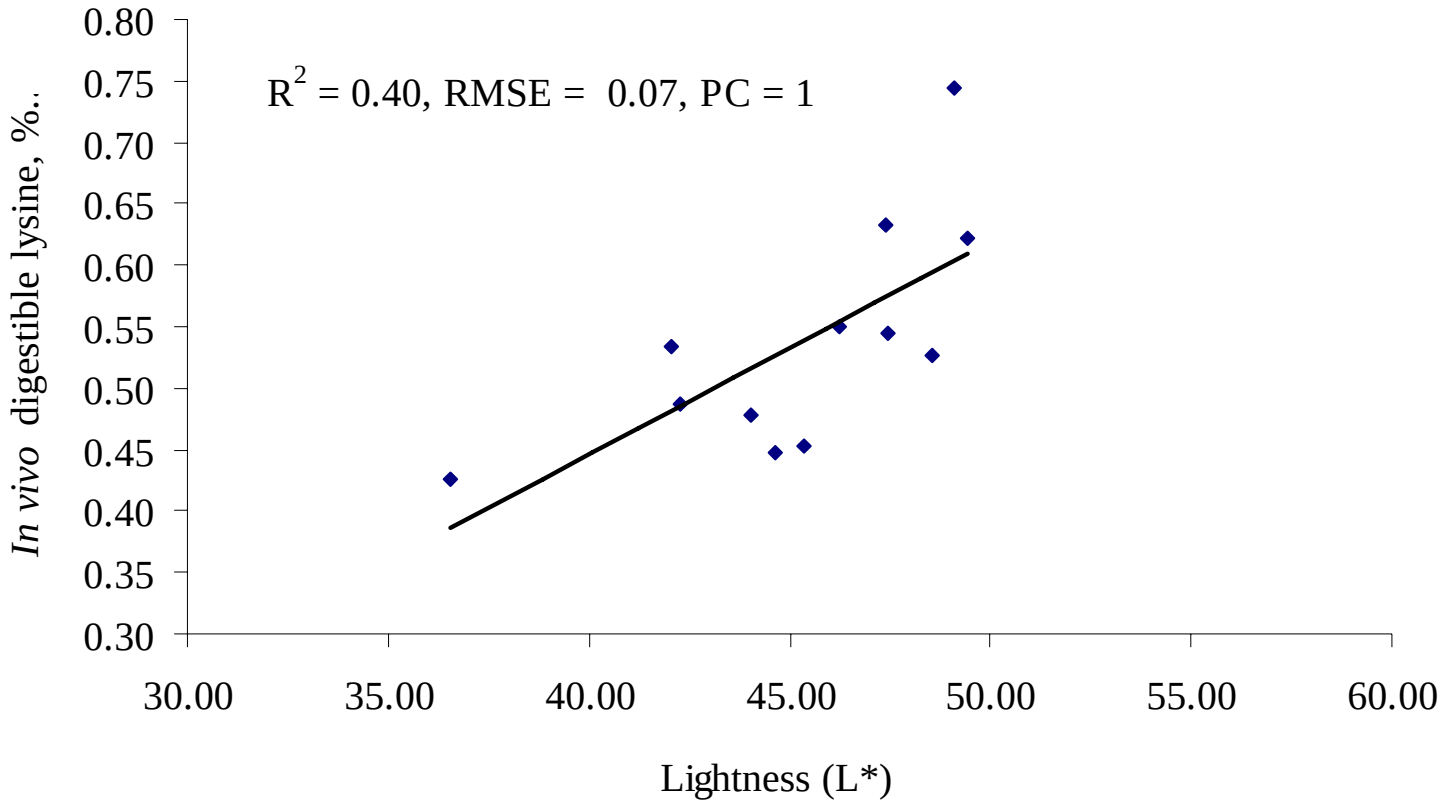


Prediction of Digestible Lysine from Color (L*, a*, and b*) Among DDGS Sources for Swine



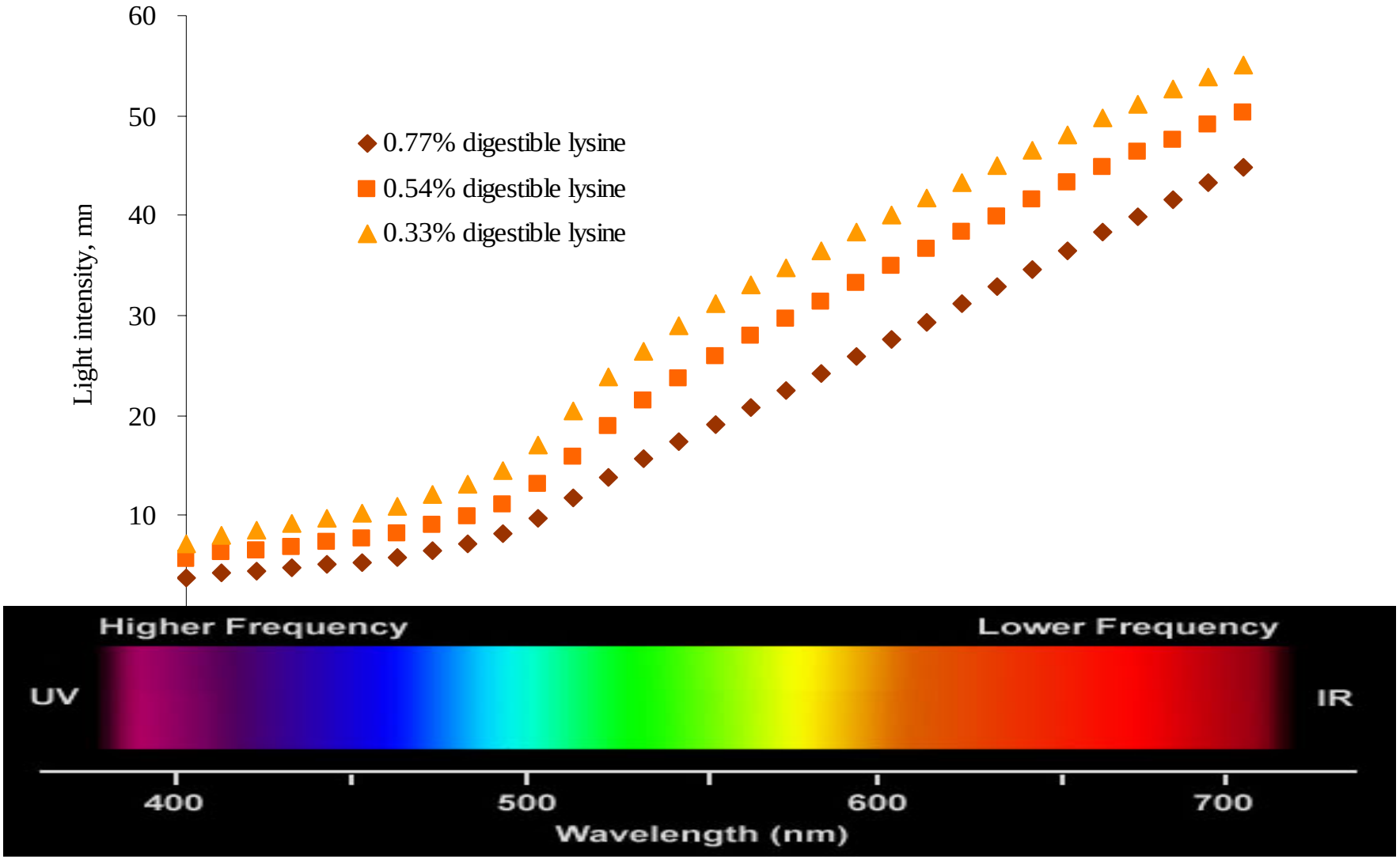
Urriola et al. (2006)

Prediction of Digestible Lysine from Color L*, a*, and b* (L* < 50 in Corn DDGS)

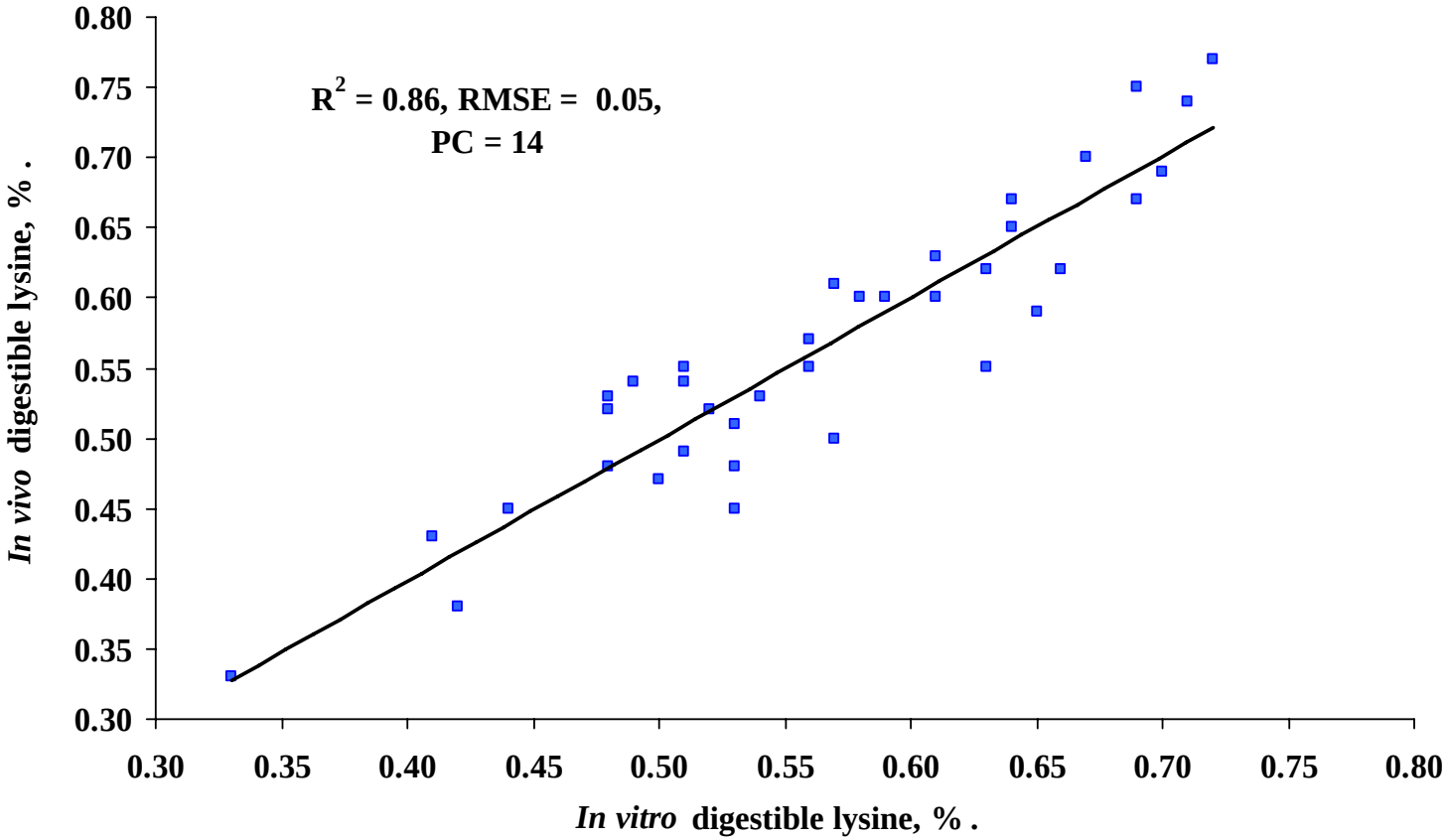


Urriola et al. (2006)

Prediction of Digestible Lysine Content of DDGS Using Optical Density

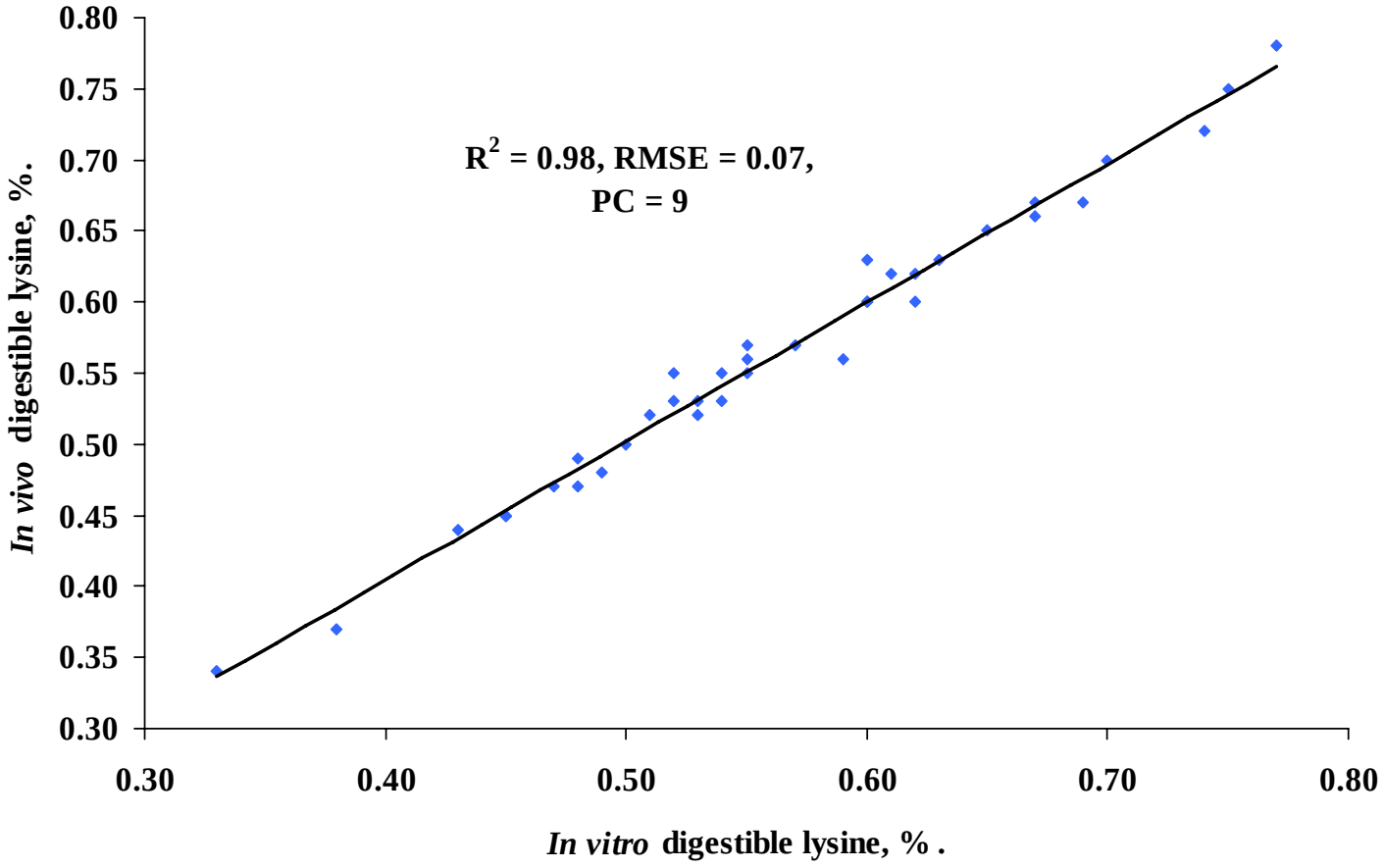


Prediction of Digestible Lysine from Optical Density (400 to 700 nm)



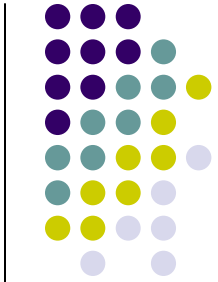
Urriola et al. (2006)

Prediction of Digestible Lysine in DDGS Using Front Face Fluorescence



Urriola et al. (2006)

Benefits and Limitations of Feeding DDGS Diets to Swine



Benefits

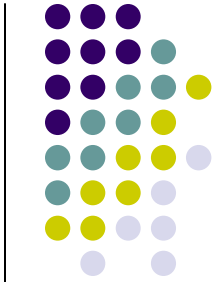
- Energy value = corn
- High available P
  - Reduce diet P supplementation
  - May reduce manure P excretion
- Partially replaces some corn, soybean meal, and dicalcium phosphate and reduces diet cost
- Commonly fed at 10% of diet
  - Higher levels can be used if amino acids are supplemented
- Only “golden” DDGS should be used
  - High amino acid digestibility
- Appears to reduce gut health problems due to ileitis
- May increase litter size weaned when fed at high levels to sows
- Increases pig weight gain when fed to sows during lactation

Limitations

- Low protein (lysine) quality
  - add other supplements high in lysine and tryptophan
- Variability in nutrient content and digestibility among sources
- Manure N excretion increases
- Belly firmness and pork fat quality may be reduced when > 20% in the diet
- Fine particle size causes flowability problems in bins and feeders
- Difficult to pellet and maintain throughput of pellet mills
- Mycotoxin free grain should be used to produce ethanol and DDGS
- Short-term feed intake may be reduced when feeding high DDGS diets to sows

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

(Based Upon University of Minnesota Performance Trials)

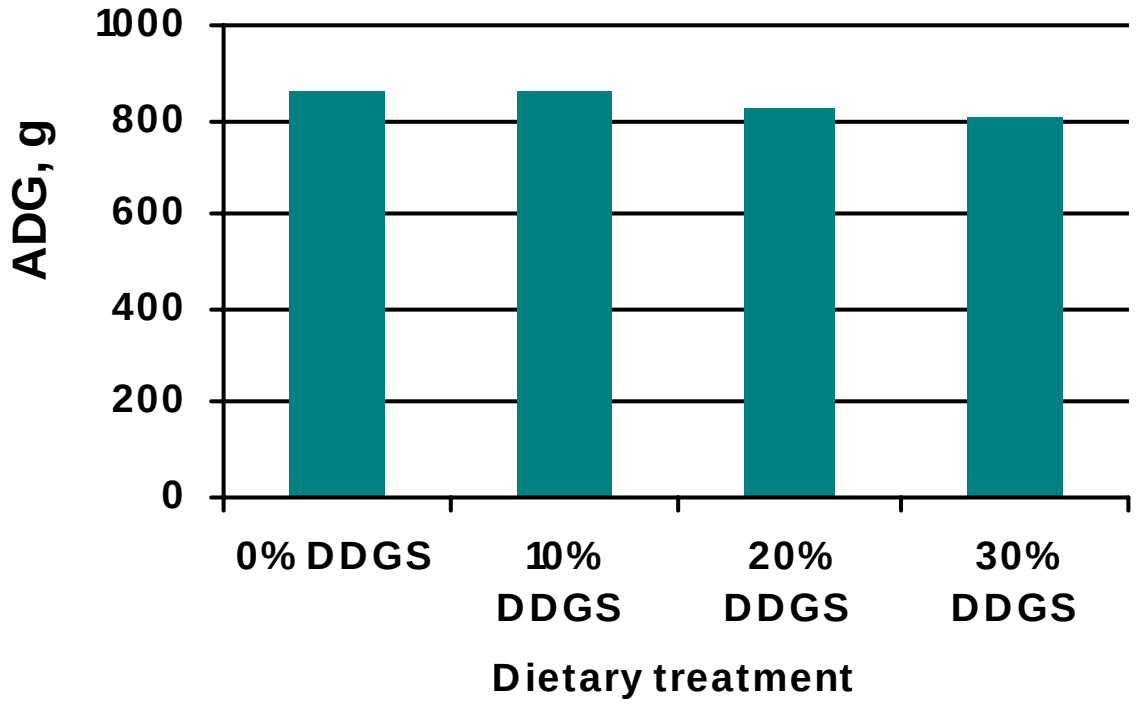


- Nursery pigs (> 7 kg)
  - Up to 25 %
- Grow-finish pigs
  - Up to 20% (higher levels may reduce pork fat quality)
- Gestating sows
  - Up to 50%
- Lactating sows
  - Up to 20%

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

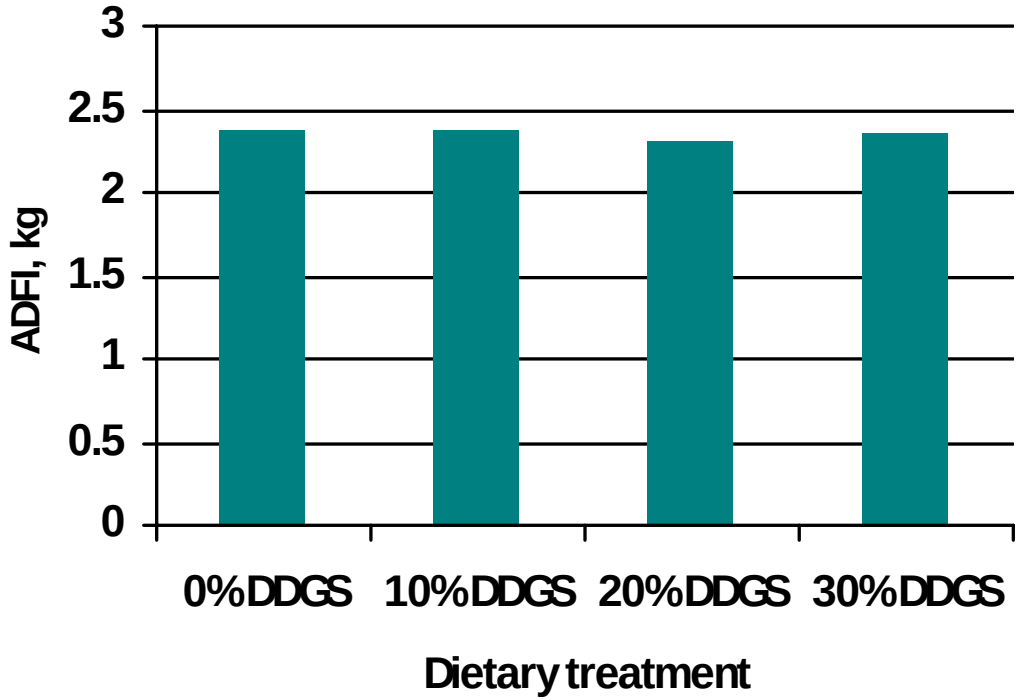
Feeding High Quality DDGS to Grow-Finish Pigs

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



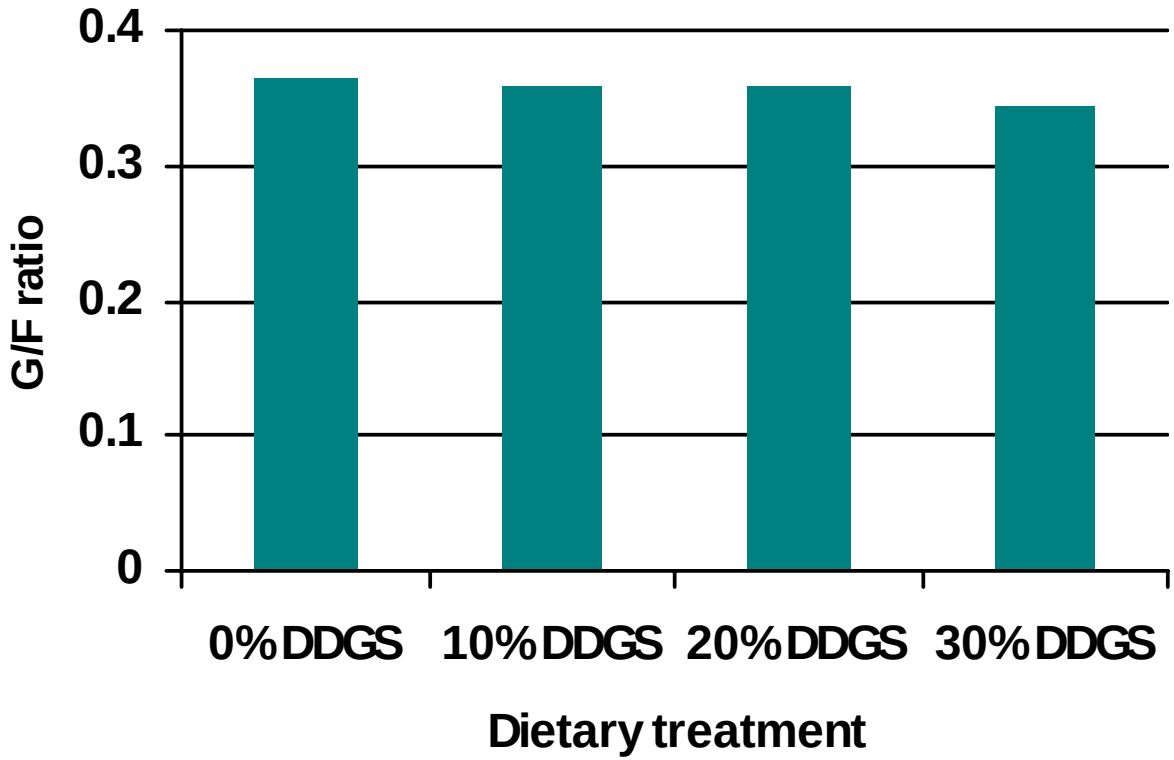
0 % and 10 % DDGS > 20% and 30% DDGS (P < .10)

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



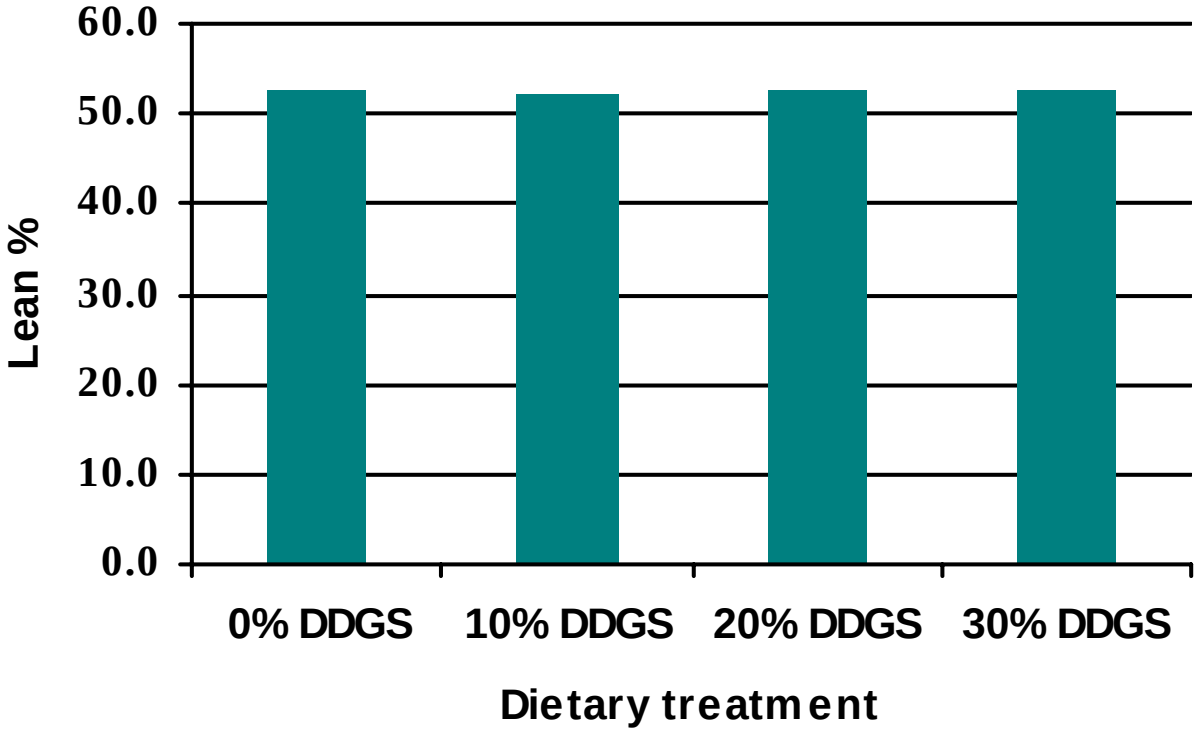
No significant differences among dietary treatments

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

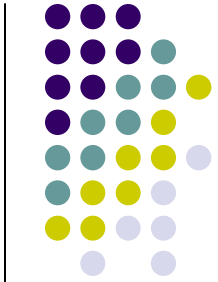
[a] 0 = black, 100 = white
[b] 1=pale pinkish gray/white; 2=grayish pink; 3=reddish pink; 4=dark reddish pink; 5=purplish red; 6=dark purplish red
[c] 1 = soft, 2 = firm, 3 = very firm
[d] Visual scale approximates % intramuscular fat content (NPPC, 1999)
[e] Total moisture loss = 11-d purge loss + 24-h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

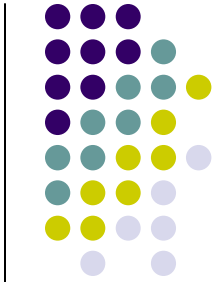
Means within a row lacking common superscripts differ (P < .05).

U of M/Land O’ Lakes Pork Fat Quality Field Study (2006)



- Facilities
  - Two commercial 1000 head finishing barns in southern MN
  - Separate sites, two independent producers
  - Each barn had 40 pens, double sided curtain
    - buildings with 8' pits
    - pit fans for ventilation
    - weighted baffle ceiling air inlets
- Genetics
  - Monsanto Genepacker sows
  - Monsanto EB terminal semen

U of M/Land O' Lakes Pork Fat Quality Field Study (2006)



- **Nutrition**
  - Provided by Land O' Lakes
  - Producer A fed typical corn-soybean meal diets
  - Producer B fed corn-soybean meal diets containing 10% DDGS
  - 7-phase mixed sex feeding program
  - Last finisher diet contained 4.5g Paylean
  - Diets contained similar nutrient levels with and without 10% DDGS
  - All diets contained choice white grease as the supplemental fat source (1.25 to 3.75%).

Carcass Characteristics of Grow-Finish Pigs Fed 0 or 10% DDGS Diets (UM/LOL Field Trial)

Measurement	0% DDGS Diets	10% DDGS Diets
Carcass weight, lbs	212	210
Last rib backfat, in.	1.09	1.11
Tenth rib backfat, in.	1.01	0.99
Ham, %	11.74	11.74
Loin, %	7.93	7.91
Belly, %	10.51	10.41
Loin depth, in.	2.72	2.72
Lean %	56.36	56.47

No significant differences in carcass characteristics.

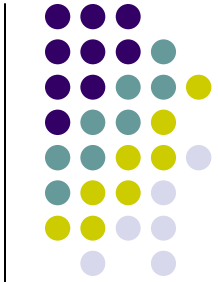
Mid-Belly Fat Quality Characteristics of Carcasses of Grow-Finish Pigs Fed 0 or 10% DDGS Diets (UM/LOL Field Trial)

Measurement	0% DDGS Diets	10% DDGS Diets
Japanese fat color score (1-4)	1.76	1.81
Mean melting point, °C	29.26	28.70
Iodine value	66.7[a]	68.3[b]
14:0, 16:0, 16:1, 17:0, 17:1, 18:0, %	No differences	No differences
18:1 oleic acid, %	47.39[c]	45.12[d]
18:2 linoleic acid, %	11.94[c]	13.98[d]
18:3, 18:4, 20:0, 20:1, 20:2, 20:4, %	No differences	No differences
Saturated fatty acids, %	33.99	34.26
Monounsaturated fatty acids, %	51.78[c]	49.47[d]
PUFA, %	14.02[c]	16.11[d]
Total Omega 3, %	0.98	0.96
Total Omega 6, %	13.02[c]	15.14[d]
Omega 6:Omega 3 ratio	13.28[c]	15.78[d]

[a, b] **Means within rows with unlike superscripts differ (P < .05).**

[c, d] **Means within rows with unlike superscripts differ (P < .0001).**

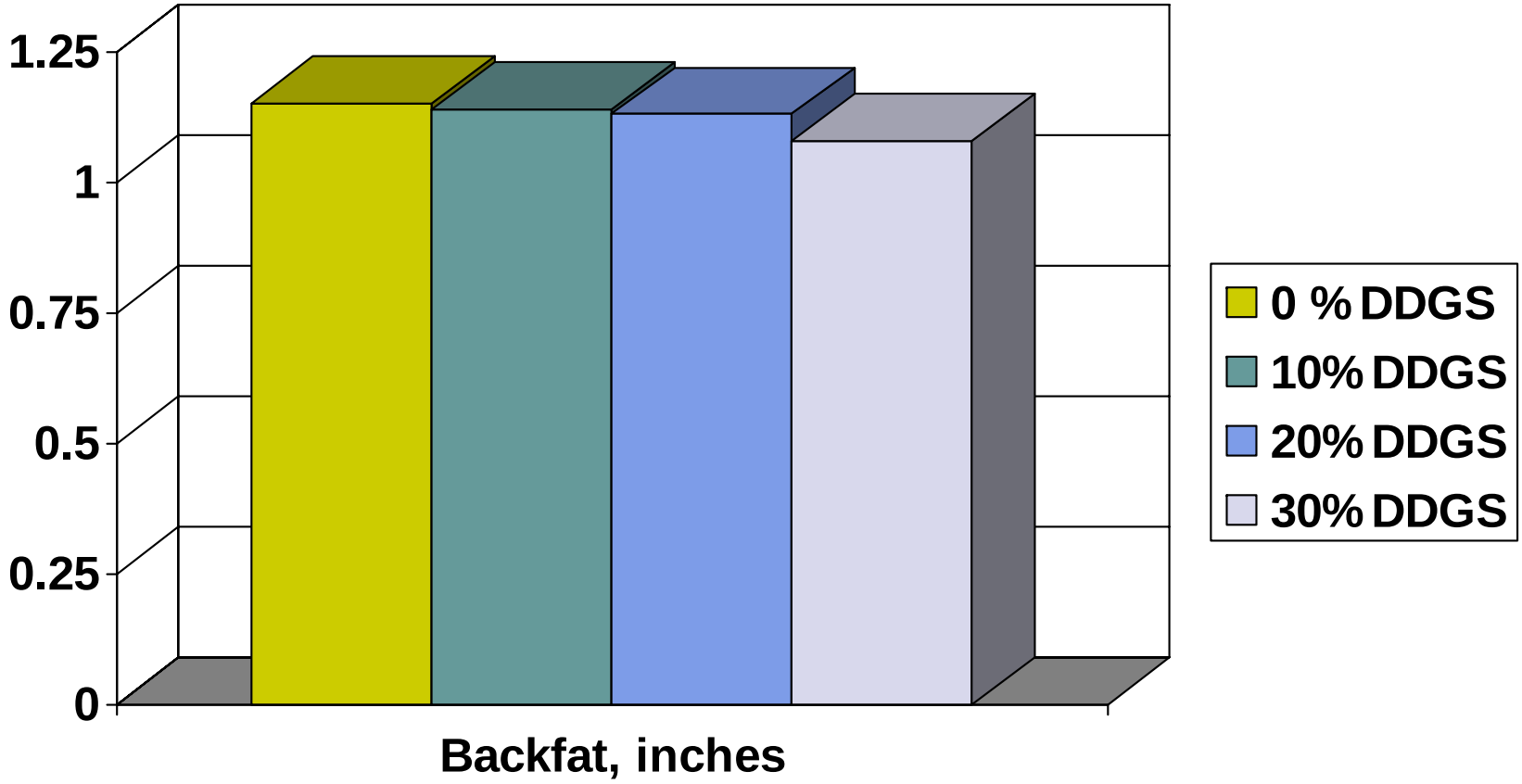
Effect of Formulating G-F Diets on a Digestible Amino Acid Basis, with Increasing Levels of DDGS, on Overall Growth Performance



	0% DDGS	10% DDGS	20% DDGS	30% DDGS
Initial wt., lbs	49.7	50.3	49.7	49.7
Final wt., lbs	252	253	251	250
ADG, lbs	2.00	2.00	1.99	1.99
ADFI, lbs	5.76	5.58	5.55	5.45
F/G	2.88	2.80	2.79	2.75

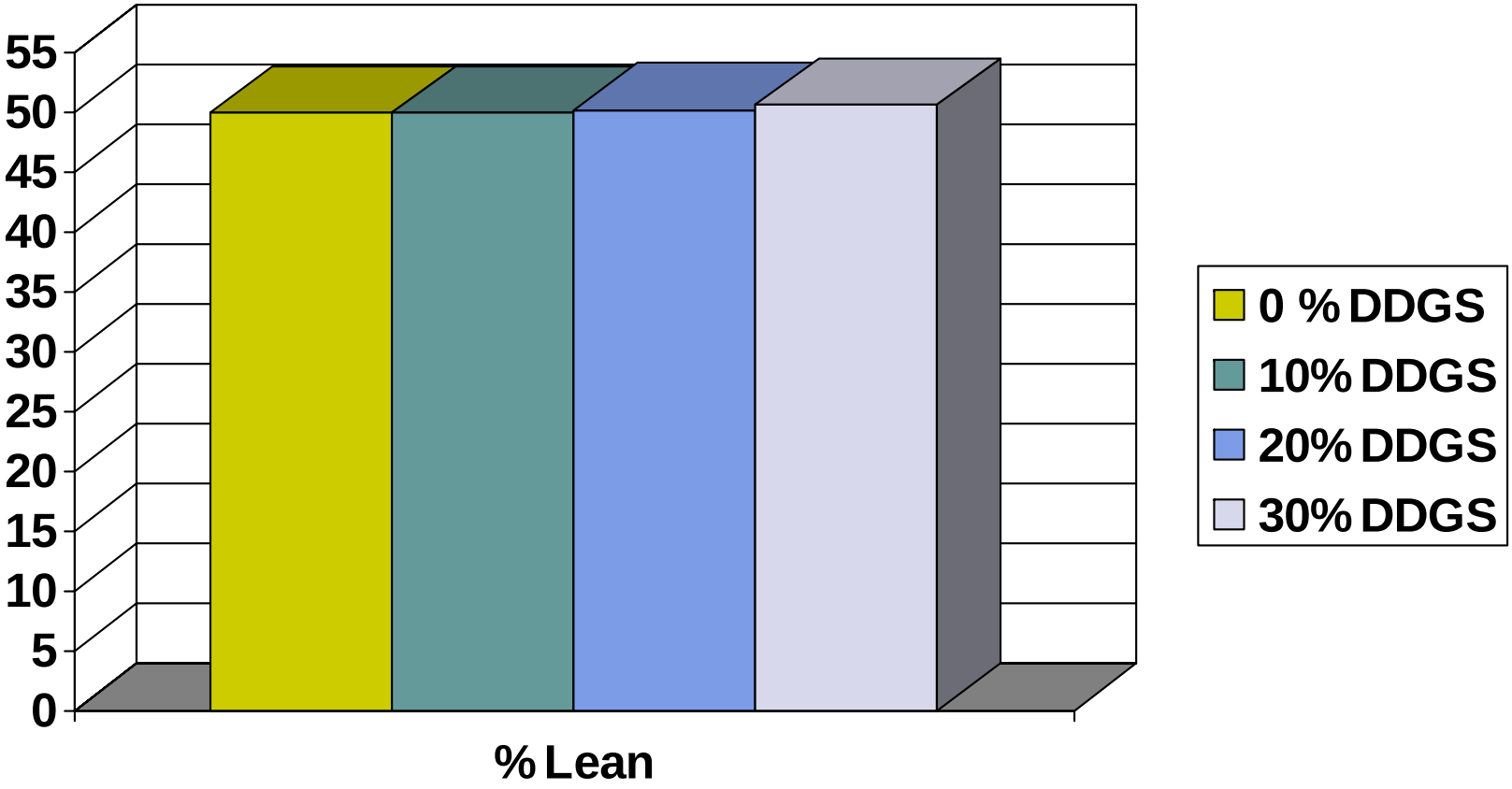
Xu et al. (2006) unpublished
Data from 32 pens, 8 pens/treatment

Effects of Dietary DDGS Level on Last Rib Backfat



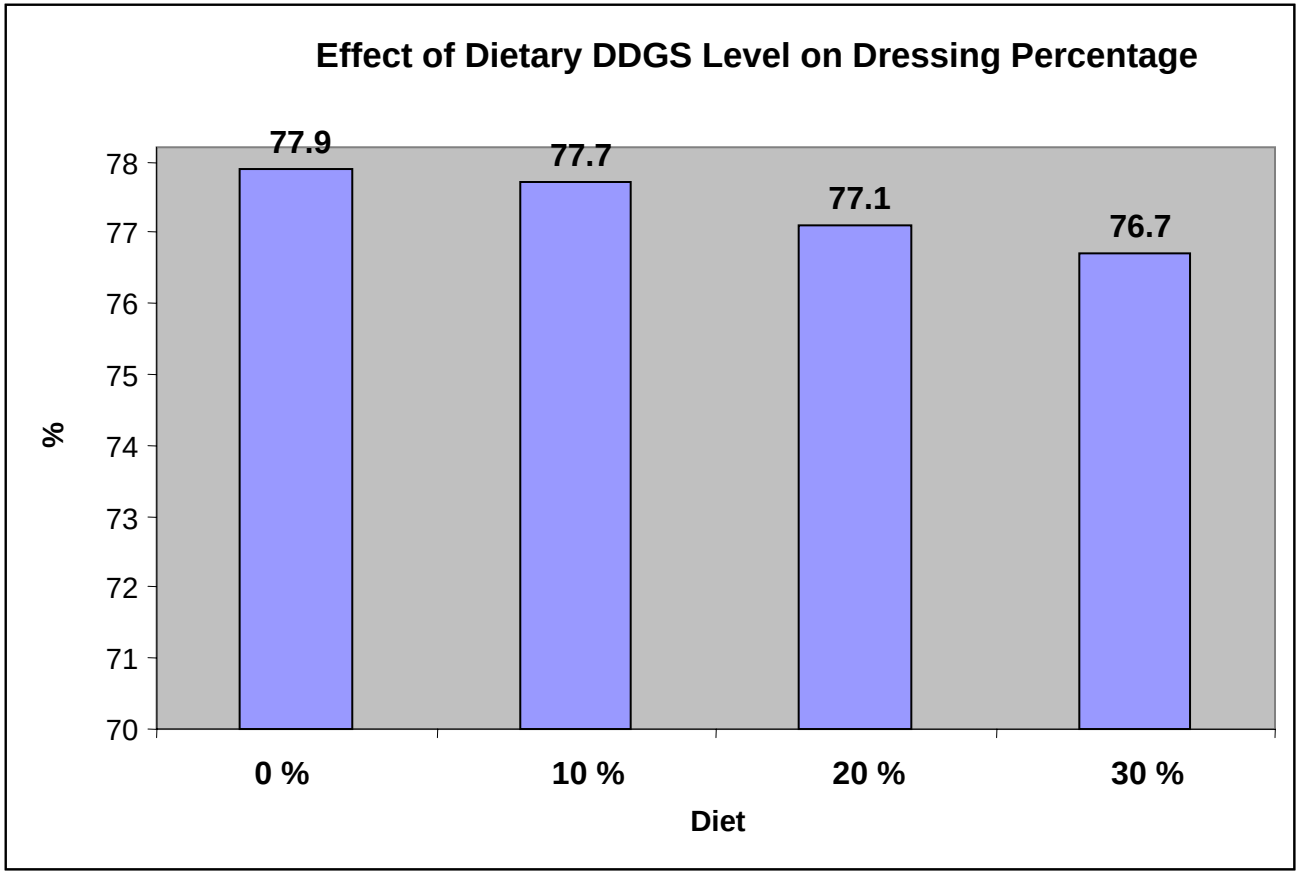
Xu et al. (2006) unpublished
30% DDGS tended to be lower than 0% DDGS (P = 0.09)

Effects of Dietary DDGS Level on % Carcass Lean



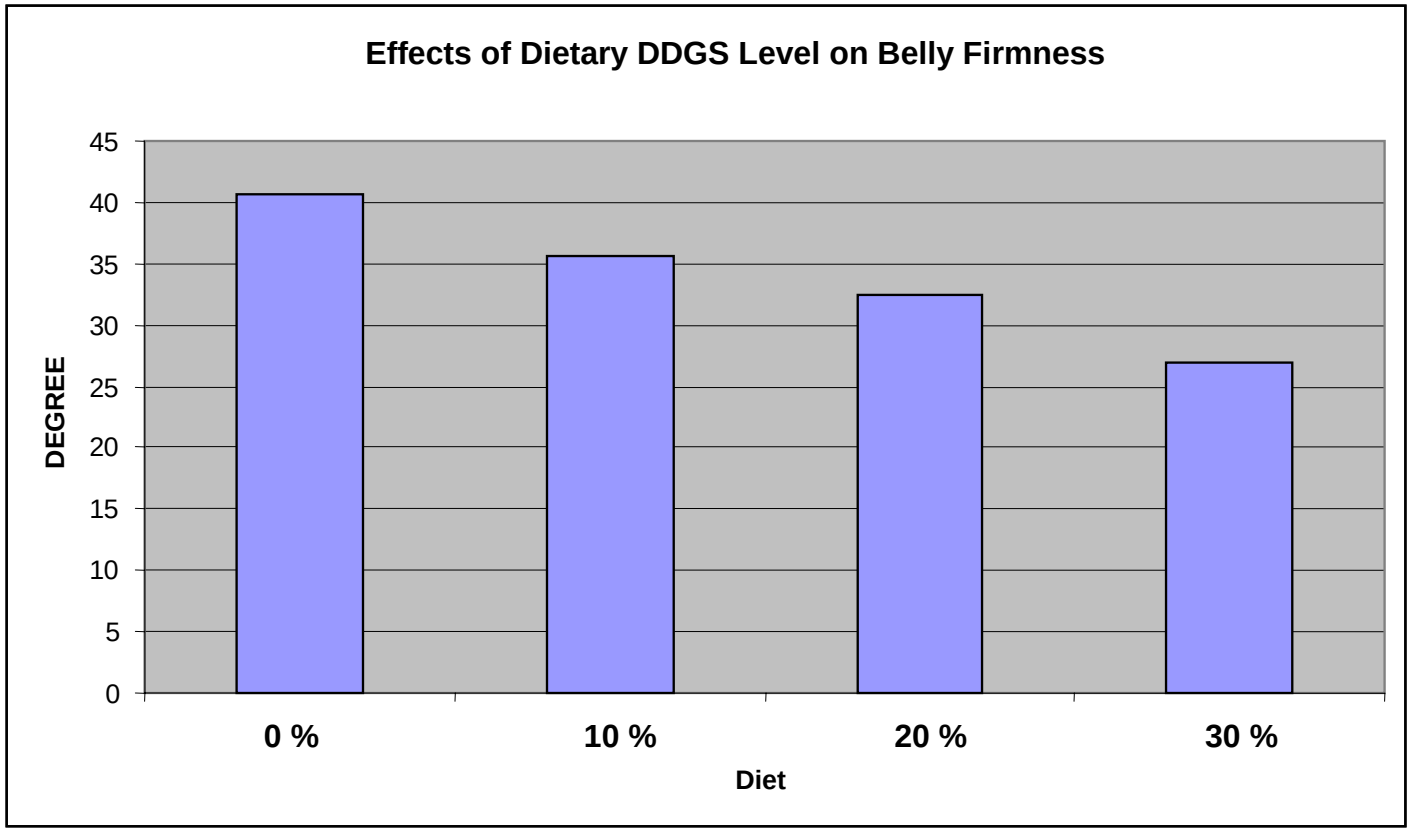
Xu et al. (2006) unpublished
30% DDGS tended to be higher than 0% DDGS (P = 0.11)

Adding DDGS to Grower-Finisher Diets Slightly Reduces Carcass Yield



Xu et al. (2006) unpublished
Linear effect ($P < 0.01$)

Adding Increasing Levels of DDGS to G-F Diets Reduces Belly Firmness



Xu et al. (2006) unpublished

Effect of Feeding Diets Containing DDGS on Feed Intake of Growing Pigs (Published)

- No Effect
  - Hansen, E.L., G.W. Libal, D.N. Peters, and C.R. Hamilton. 1997. J. Anim. Sci. Vol. 75 (Suppl. 1) p. 194.
  - Whitney, M.H., G.C. Shurson, L.J. Johnston, D. Wulf, and B. Shanks. 2001. J. Anim. Sci. 79:108 (Suppl. 1).
  - Whitney, M.H. and G.C. Shurson. 2004. J. Anim. Sci. 82:122-128.
  - DeDecker, J.M., M. Ellis, B.F. Wolter, J. Spencer, D.M. Webel, C.R. Bertelsen, and B.A. Peterson. 2005. J. Anim. Sci. Vol. 83 (Suppl. 2) p. 79.
- Decrease
  - Fu, S.X., M. Johnston, R.W. Fent, D.C. Kendall, J.L. Usry, R.D. Boyd, and G.L. Allee. 2004. J. Anim. Sci. Vol. 82 (Suppl. 2) p. 50.
  - Hastad, C.W., J.L. Nelssen, R.D. Goodband, M.D. Tokach, S.S. Dritz, J.M. DeRouchey, and N.Z. Frantz. 2005. J. Anim. Sci. Vol. 83 (Suppl. 2) p. 73.

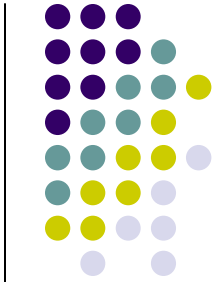
Effect of DDGS Level on ADFI[a] of Growing-Finishing Pigs

DDGS	0%	10%	20%	30%
Phase 1, lb[b]	3.34	3.29	3.20	3.03
Phase 2, lb[c]	5.04	5.02	4.84	4.65
Phase 3, lb[c]	5.84	5.83	5.60	5.57
Phase 4, lb	6.53	6.77	6.51	6.43
Phase 5, lb	7.35	7.29	7.27	7.08
Overall[b]	5.93	5.96	5.81	5.67

[a]Data are means of 48 individually penned pigs
[b]Linear effect of increasing DDGS in the diet (P < 0.01)
[c]Linear effect of increasing DDGS in the diet (P < 0.05)

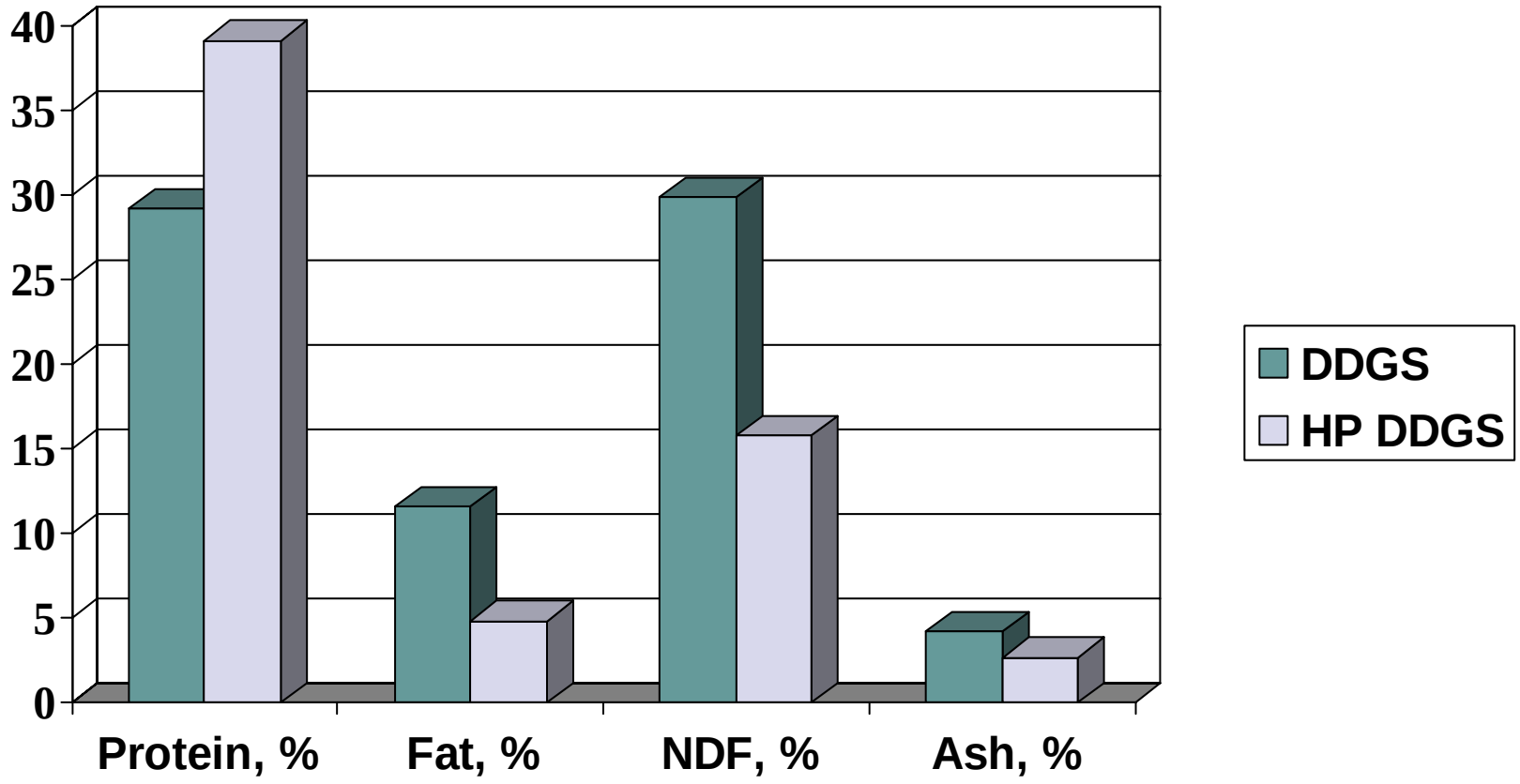
Source: de Rodas (2005) LOL-Purina Feeds

New Distiller's Grains By-Products

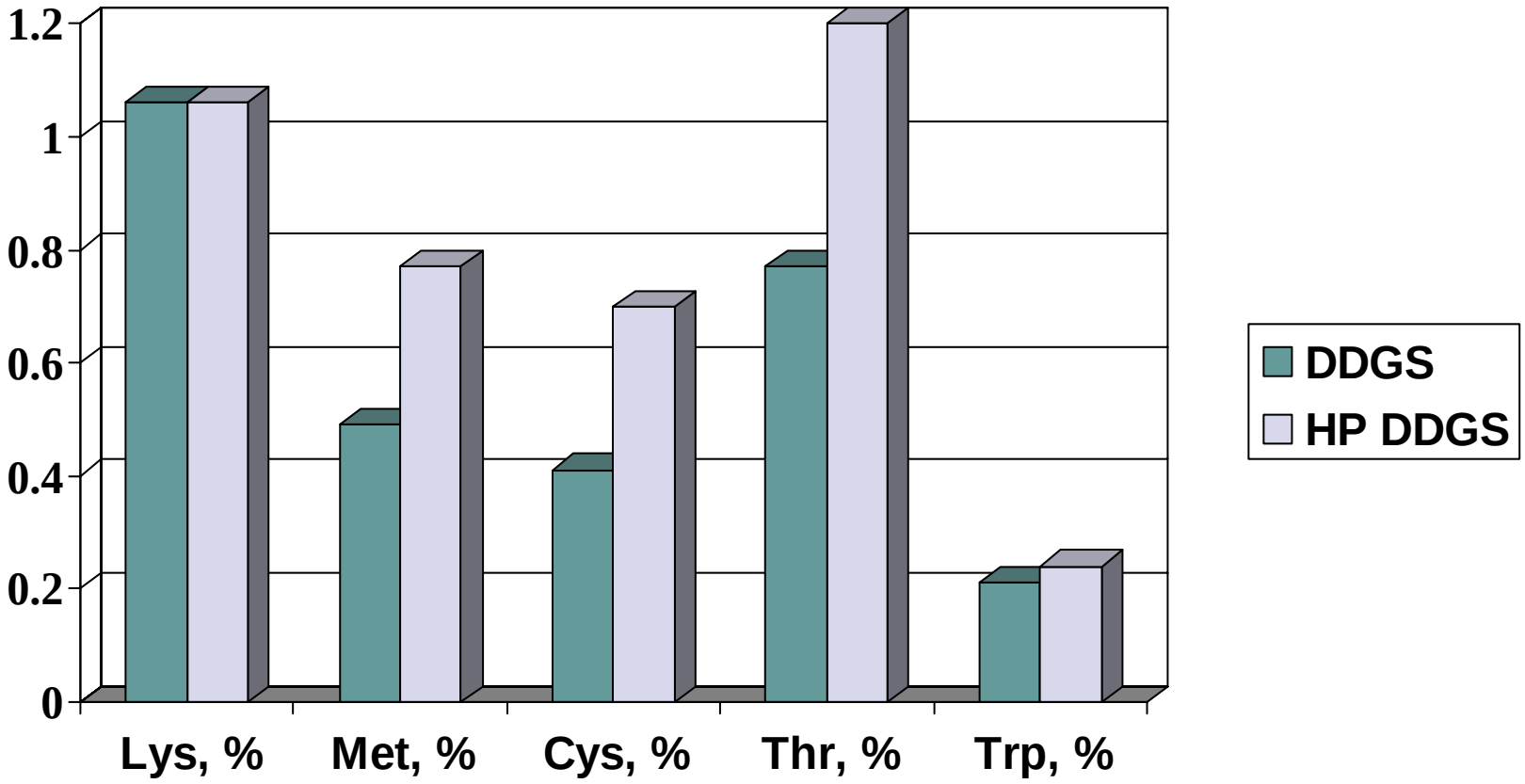


- Examples of modified processes
  - Use of new enzyme technology to increase DDGS protein
  - Removal of bran and/or germ prior to fermentation
  - Removal of phosphorus

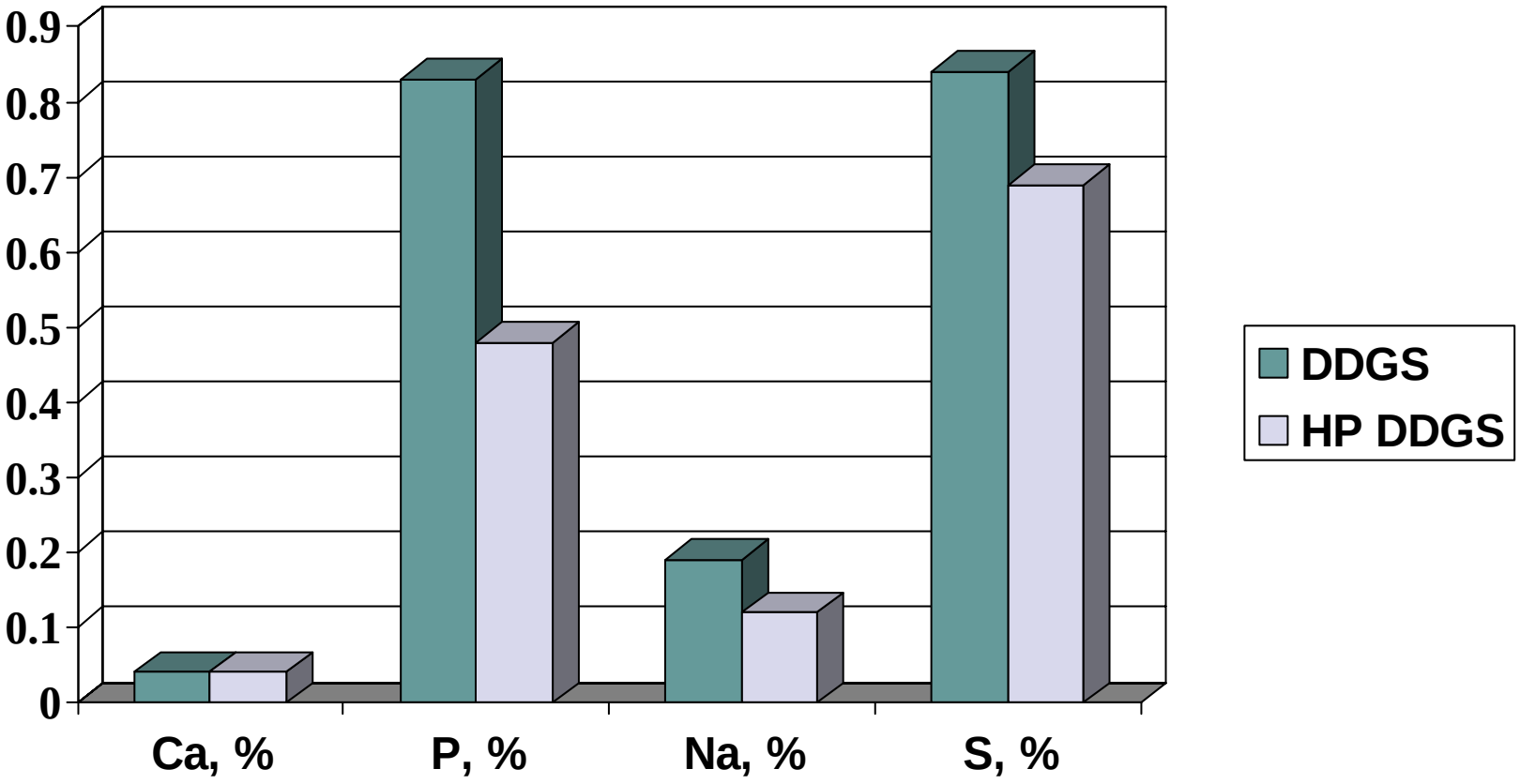
Comparison of Nutrient Content of Dakota Gold DDGS with High Protein Dakota Gold (100% DM Basis)



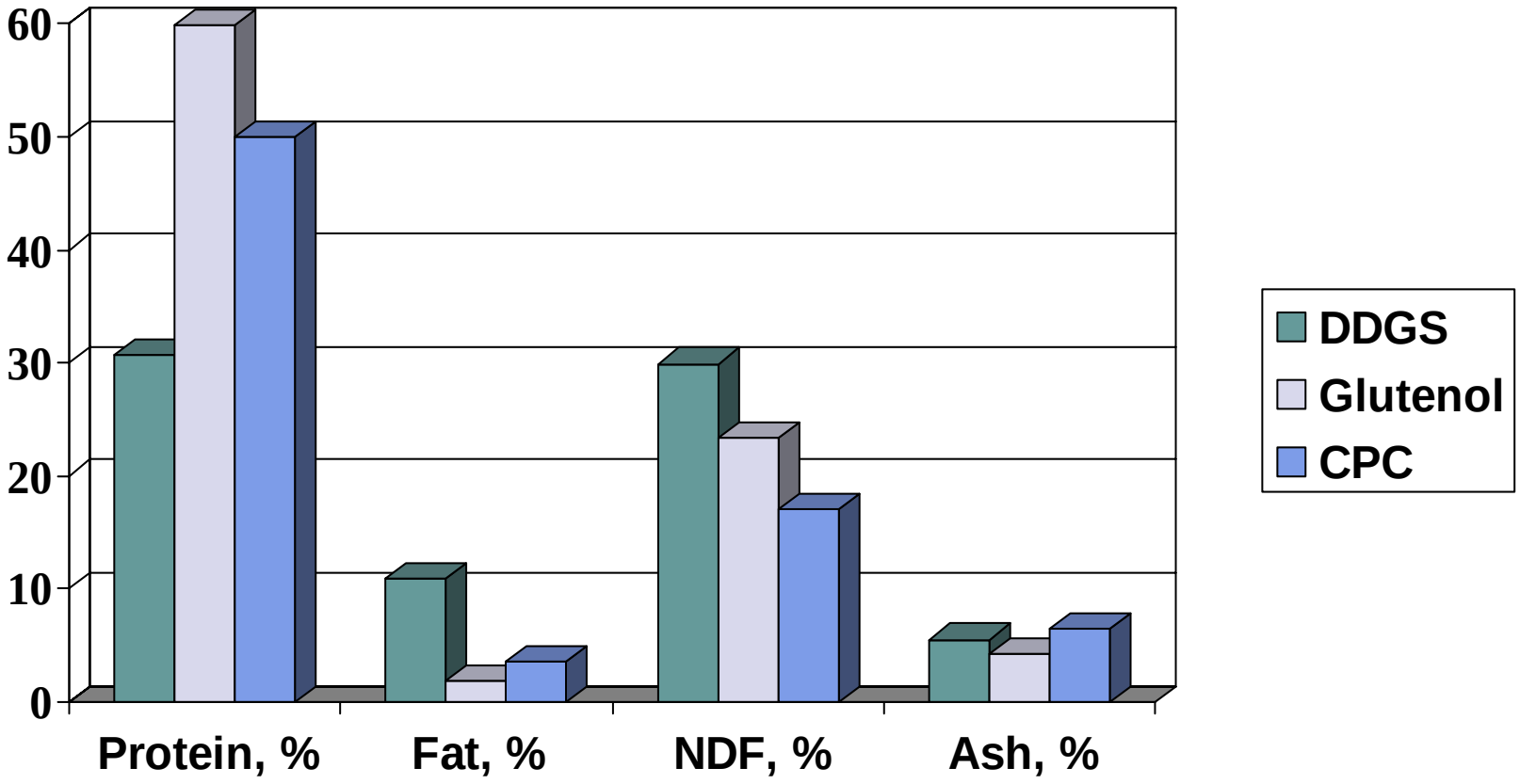
Comparison of Amino Acid Content of Dakota Gold DDGS with High Protein Dakota Gold (100% DM Basis)



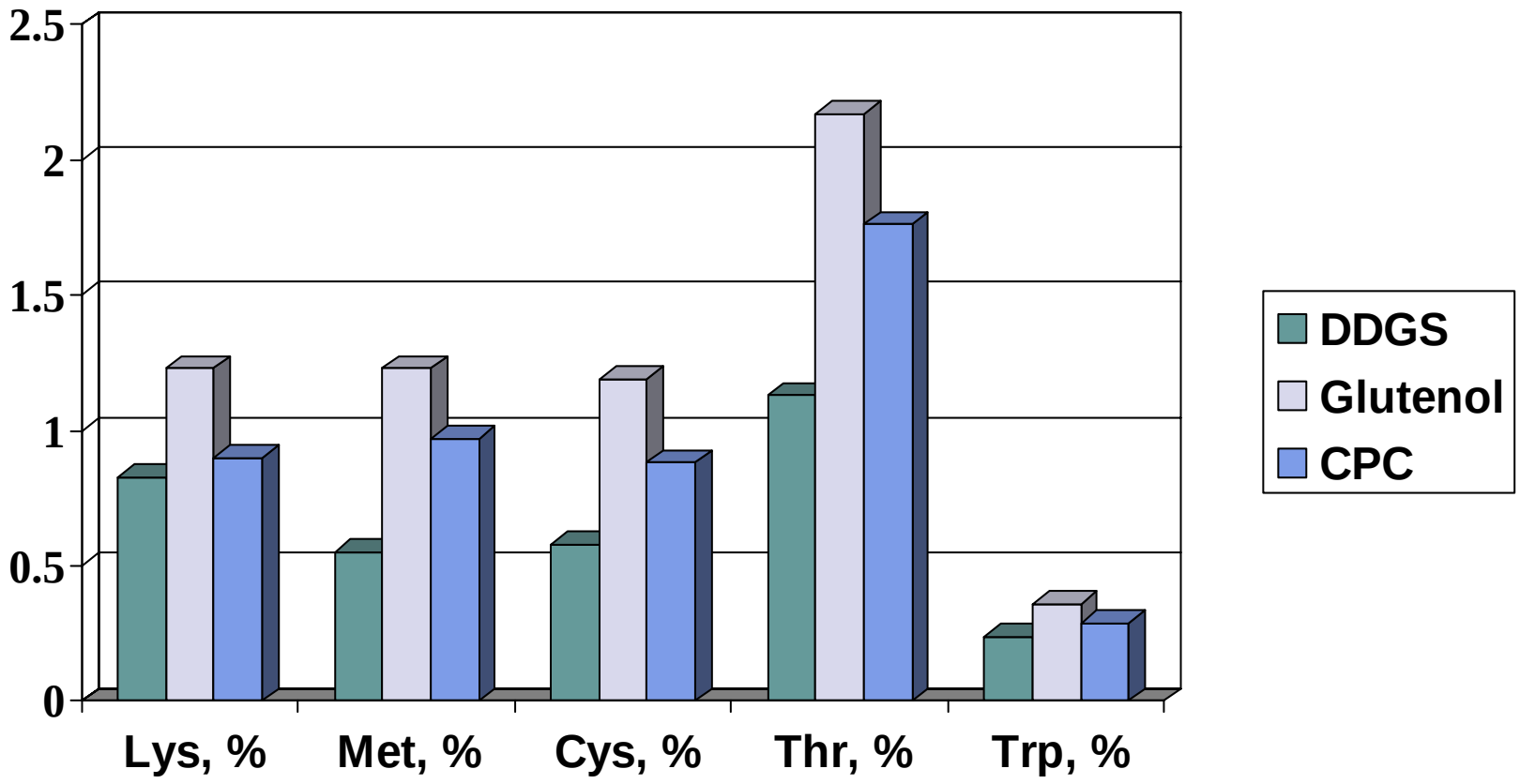
Comparison of Mineral Content of Dakota Gold DDGS with High Protein Dakota Gold (100% DM Basis)



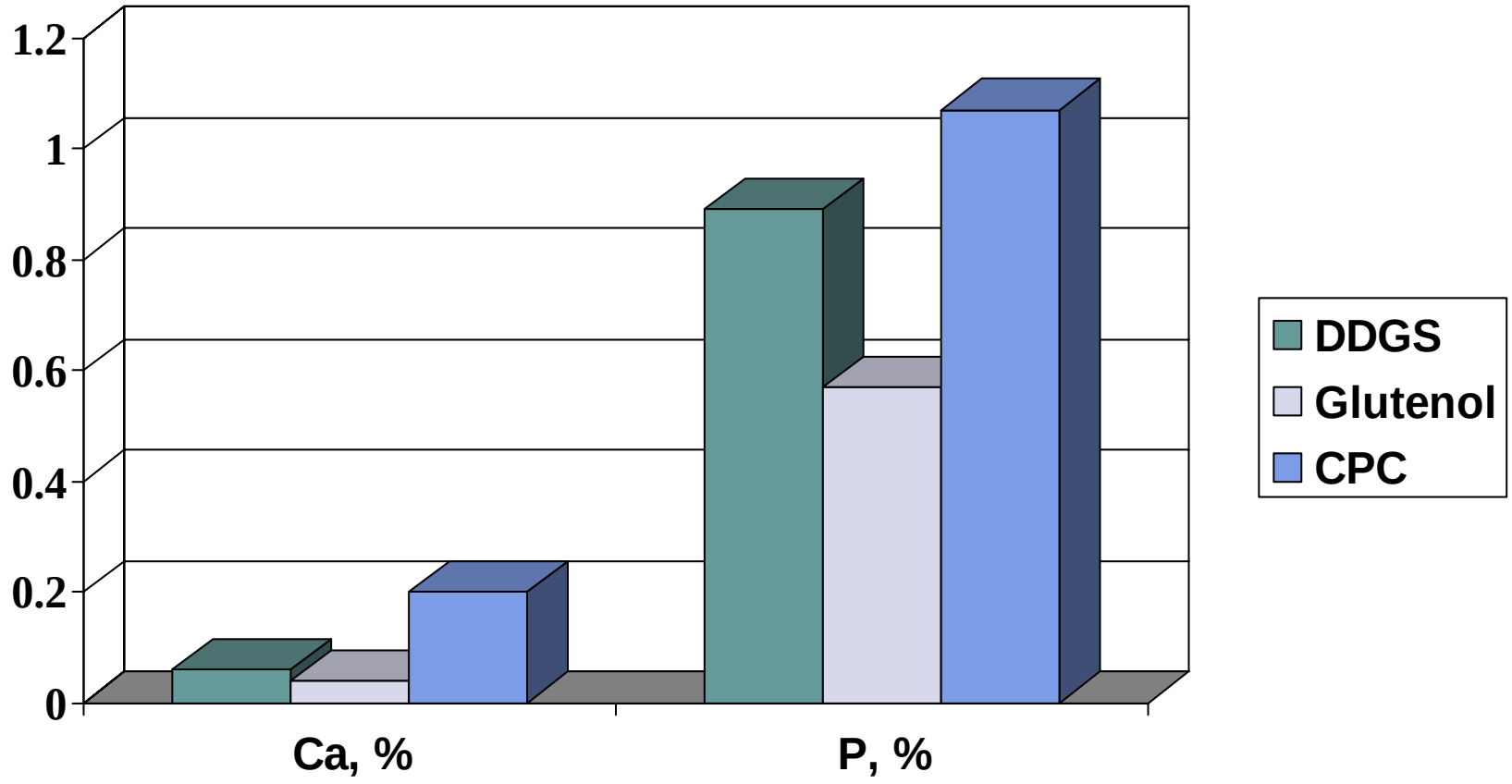
Comparison of Nutrient Content of DDGS with Glutenol and Corn Protein Concentrate (100% DM Basis)



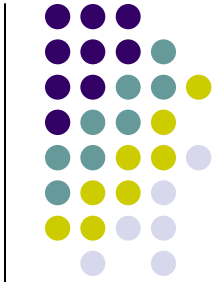
Comparison of Amino Acid Content of DDGS with Glutenol and Corn Protein Concentrate (100% DM Basis)



Comparison of Calcium and Phosphorus Content of DDGS with Glutenol and Corn Protein Concentrate (100% DM Basis)

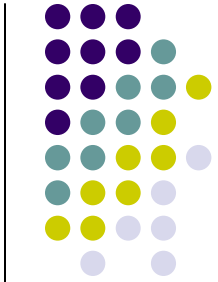


Opportunity Costs of Corn By-Products in Swine Diets



	DDGS Spec. 1	DDGS Spec. 2	HP DDGS	Glutenol	CPC
Swine	$80.00	$78.00	$51.00	$63.40	$61.60

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