Using Corn Distillers By-Products in Turkey Rations

Sally Noll
Extension Poultry Specialist
University of Minnesota

What is DDGS?

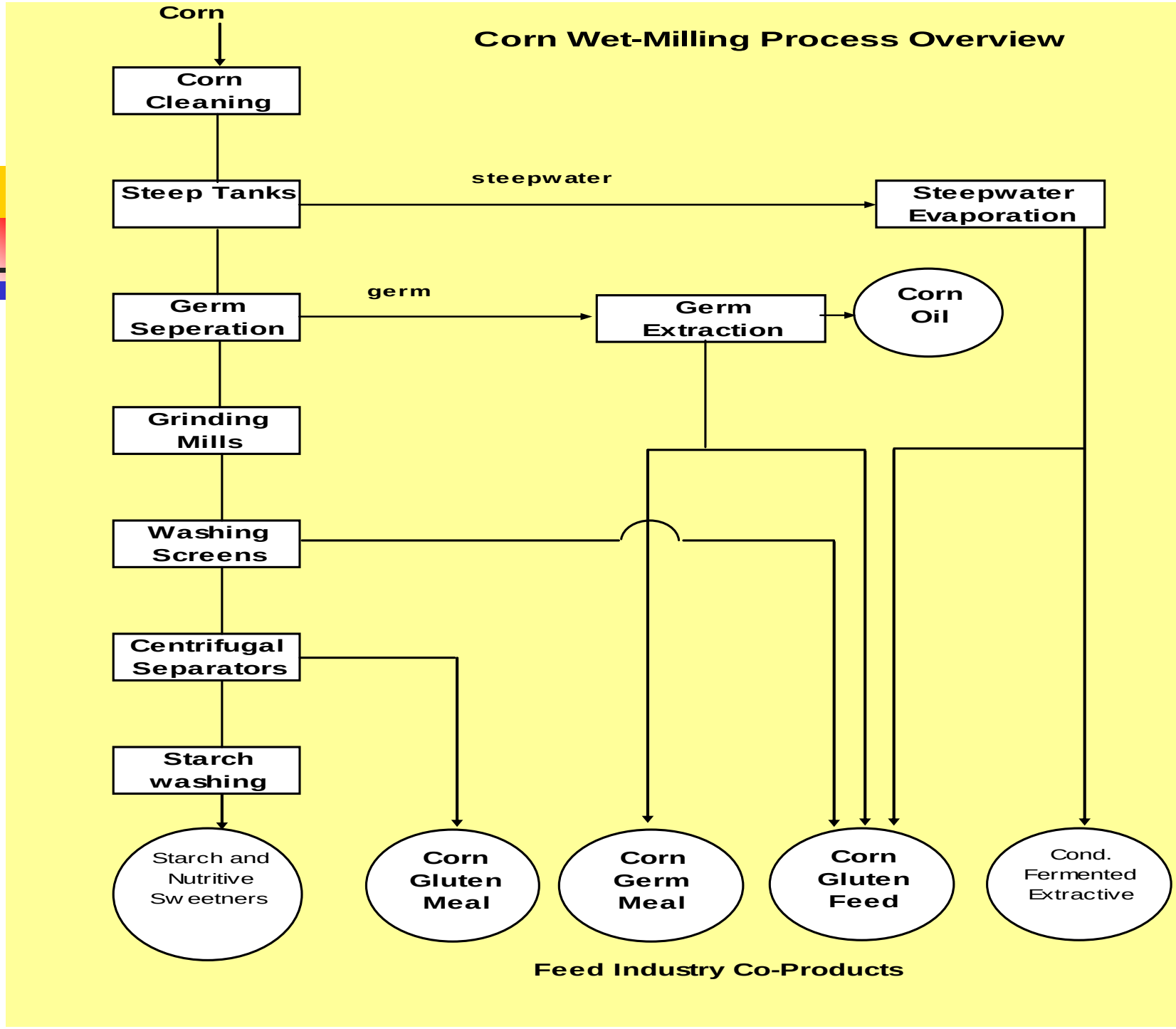
- **Distiller's dried grains with solubles (DDGS)**
  - By-product of the **dry-milling** ethanol industry
- Nutrient composition is **different** between dry-mill, wet-mill and beverage alcohol by-products
  - DDGS – fuel ethanol
  - DDGS - whiskey distilleries
  - Corn gluten feed – wet mill
  - Corn gluten meal – wet mill
  - Brewer's dried grains – beer manufacturing
- Nutrient content depends on the grain source used
  - **Corn DDGS - Midwestern US**
  - Wheat DDGS - Canada
  - Sorghum (milo) DDGS - Great Plains US
  - Barley DDGS

Corn Processing

- Wet milling-starch, oil
- Dry milling
  - Human food application (Cereals, oil, corn meal)
  - Ethanol production
  - Brewing
- Large variety of products available
  - Seeing different by-product compositions as corn processors meet specific markets

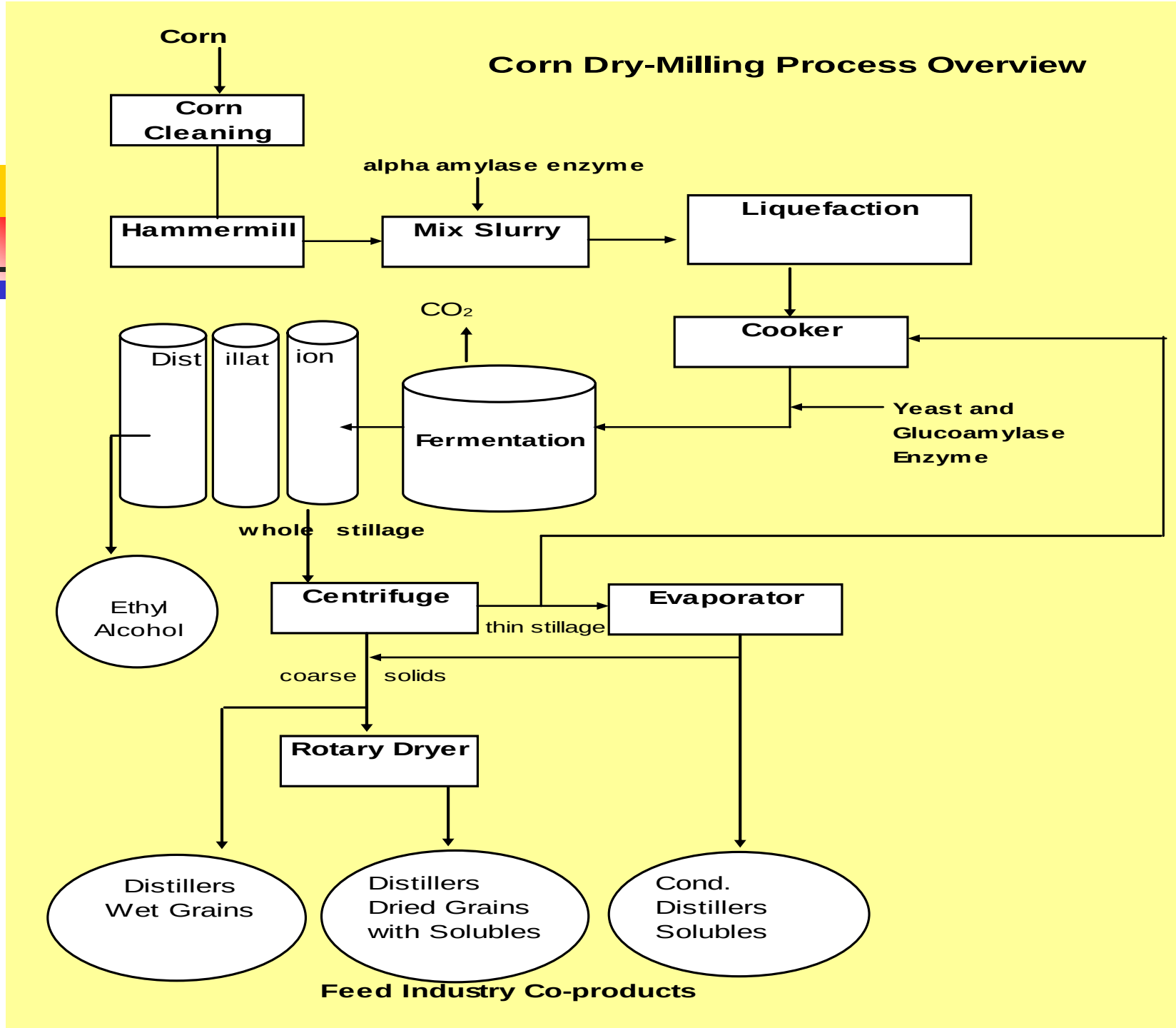
Wet Milling

- Used for the production of starch and oil
- Feed products produced
  - Condensed corn fermented extractives
  - Corn germ meal (oil removed)
  - Corn gluten feed (bran, fiber)
  - Corn gluten meal (gluten protein)


Corn
Corn Wet-Milling Process Overview
Corn Cleaning
Steep Tanks
steepwater
Steepwater Evaporation
Germ Seperation
germ
Germ Extraction
Corn Oil
Grinding Mills
Washing Screens
Centrifugal Separators
Starch washing
Starch and Nutritive Sweetners
Corn Gluten Meal
Corn Germ Meal
Corn Gluten Feed
Cond. Fermented Extractive
Feed Industry Co-Products

Dry mill – ethanol production

- Fermentation process
  - Several potential starch sources – grains, etc.
- Feed products produced-defined by input grain – corn, rye, wheat, sorghum, etc.
  - Condensed solubles
  - Distiller grains (wet or dry)
  - Distiller grains with solubles (wet or dry)


Corn
Corn Dry-Milling Process Overview
Corn Cleaning
alpha amylase enzyme
Hammermill
Mix Slurry
Liquefaction
Cooker
CO_2
Dist
illat
ion
Fermentation
Yeast and Glucoamylase Enzyme
whole stillage
Ethyl Alcohol
Centrifuge
thin stillage
Evaporator
coarse solids
Rotary Dryer
Distillers Wet Grains
Distillers Dried Grains with Solubles
Cond. Distillers Solubles
Feed Industry Co-products

Distillers Products Definitions

- 27.6 ____ **Distillers Dried Grains with Solubles** is the product obtained after the removal of ethyl alcohol by distillation from the yeast fermentation of a grain or a grain mixture by condensing and drying at least ¾ of the solids of the resultant whole stillage and drying it by methods employed in the grain distilling industry. The predominating grain shall be declared as the first word in the name.

Corn By-Products
Why proper identification is important

	Corn	Distillers Grains Dehyd	Distillers Solubles Dehyd.	Distillers Grains Plus Solubles Dehyd (DDGS)	Corn Gluten Meal
ME kcal/lb	1519	894	1330	1125	1687
Protein %	8.5	27.8	28.5	27.4	62
Lysine %	.26	.78	.9	.75	1.03

Book values, NRC 1994

Benefits and Limitations of DDGS for Poultry

Benefits

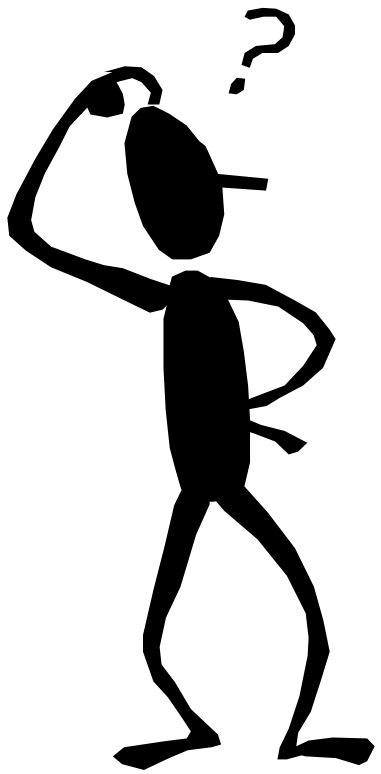
- Moderate energy and amino acid source when limited to < 20% of the diet
- Source of highly available P
  - Reduce manure P
- May improve egg yolk and skin color (xanthophyll)
- Source of “unidentified growth factors” (yeast components?)
- Palatable (no feed rejection)
- Reduced ammonia emissions (ISU, Bregendahl, 2006)
  - Chicken layers
  - Turkeys???

Limitations

- Energy value ~ 84% of corn
- Low protein quality
  - Low in lys, arg, trp
- Sources high in sodium may increase litter moisture if adjustments to dietary salt levels are not made
- Phosphorus levels can be in excess in combination with animal by-product inclusion

Questions to Ask When Using DDGS

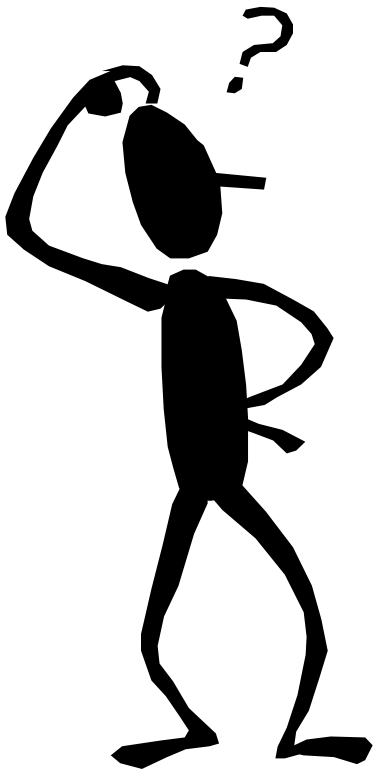
- What is the nutrient composition of the product (variability)
- What does the diet look like with DDGS
- What levels of inclusion
- Mesh with alternative protein ingredients



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

Questions to Ask When Using DDGS

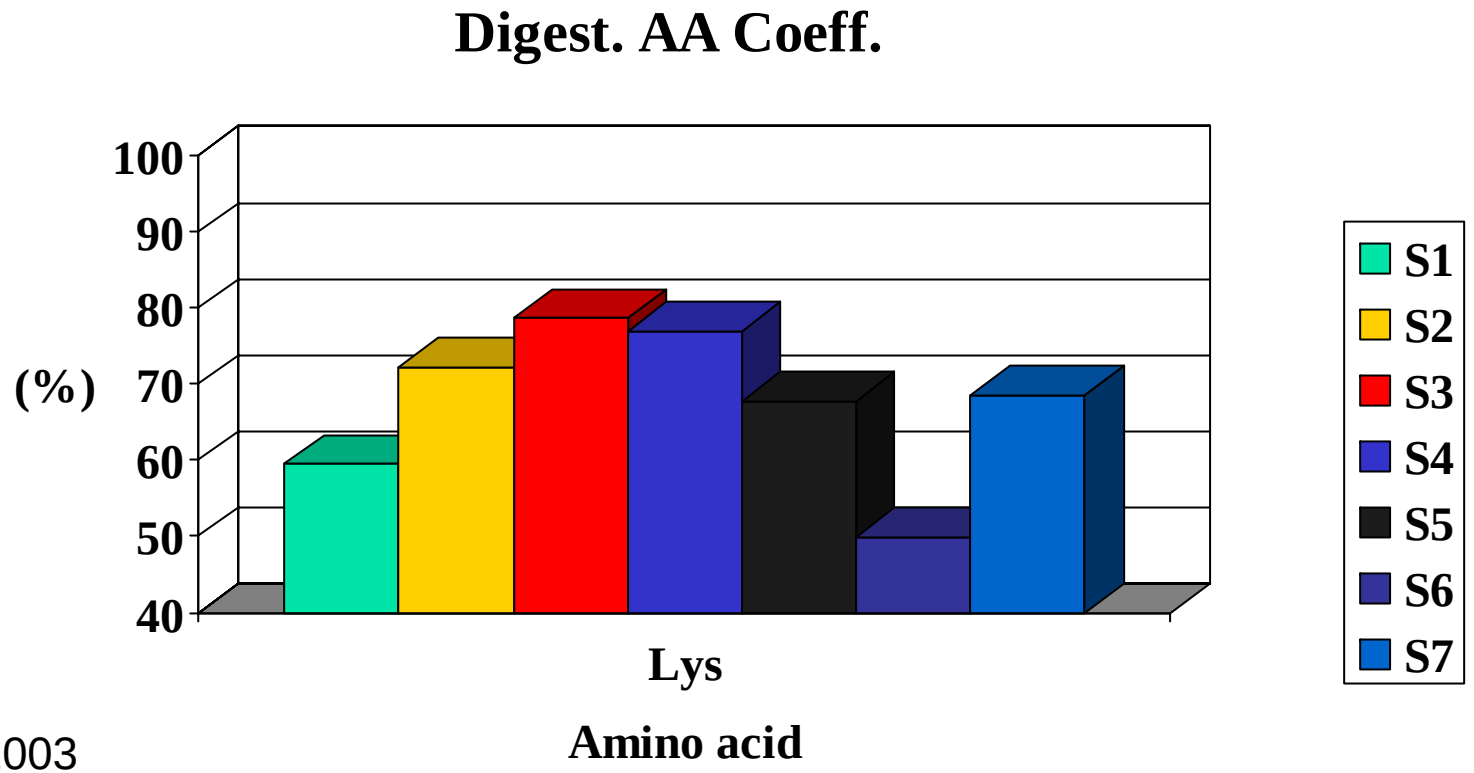
- What is the nutrient composition of the product ?
  - Energy
  - Lysine content
    - Total
    - Digestible
  - Phosphorus
    - Bioavailability



Lysine Content and Digestibility

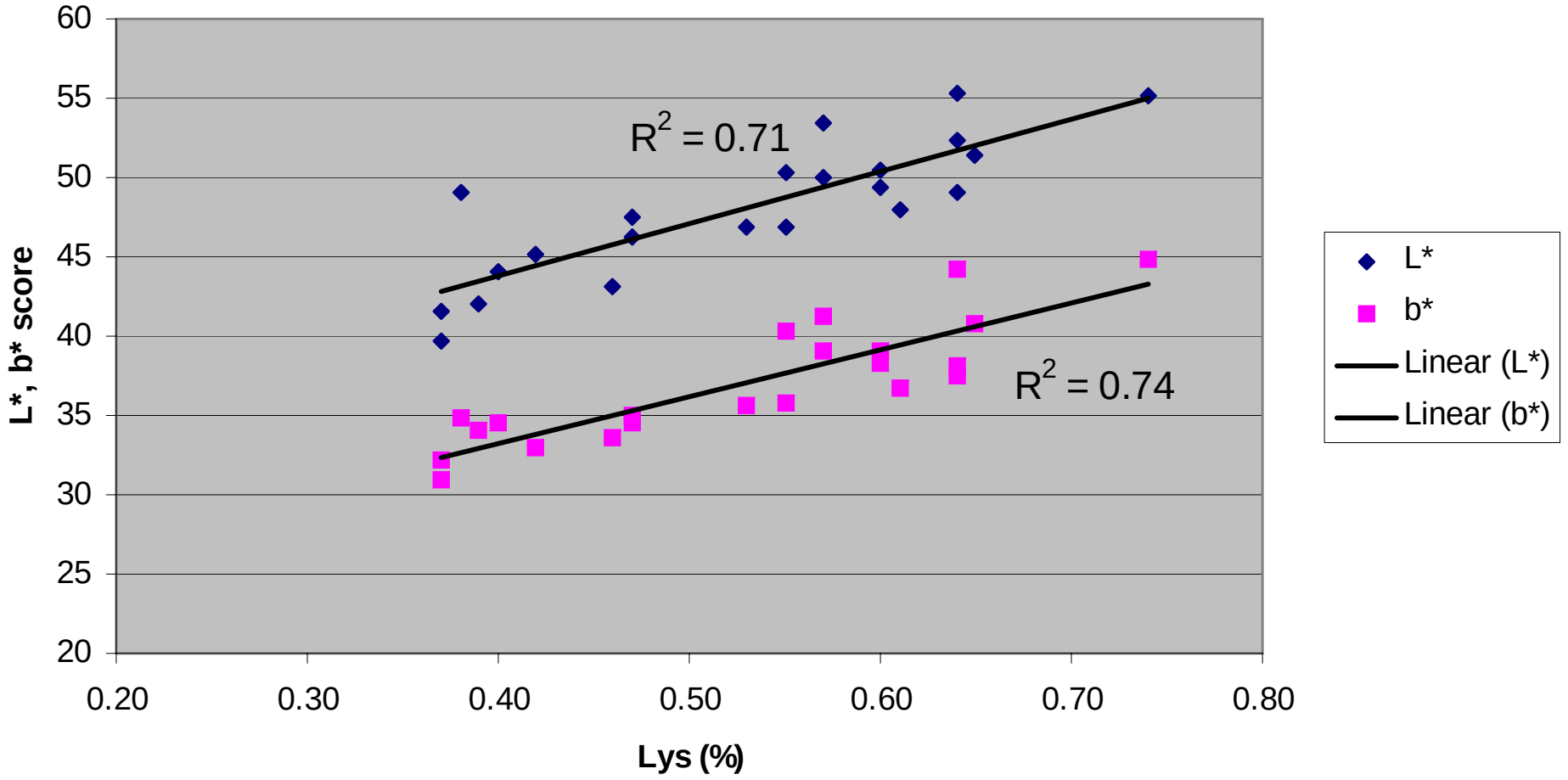
Source	No. of Samples	Lysine Content (%)		Lysine Digestibility Coefficient (%)	
		Ave.	Range	Ave.	Range
Ergul et al. 2003[1]	**20**	**.73**	**.59-.89**	**72**	**59-84**
Batal and Dale 2006[2]	8	.71	.39-.86	70	46-76
Fastinger et al. 2006[1]	5	.64	.48-.75	76	65-82

Lysine Digestibility for Poultry as Affected by Production Source



Ergul et al., 2003

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



Source: Dr. Sally Noll (2003)

Metabolizable Energy for DDGS

- Energy level
  - Feed conversion
  - Least cost formulation for high energy diets
- Other determinations higher than NRC

  reported value of

  AMEn 1125 kcal/lb

Source	AMEn (kcal/lb)	TMEn
NRC, 1994	1125	
Potter, 1966	1300	
Noll, 2004	1280	1280
Roberson 2004	1250	
Batal & Dale, 2006		1280

Availability of Phosphorus

Ingredient	P, %	P, avail. %	% P Avail.
Corn*	.28	.08	28
SBM*	.62	.22	35
DDGs*	.72	.39	54
DDGs (UGA)	.74	~.47	61-68 (64)
DDGs(UI) DDGs (MSU)	.73	~.6	69-102 (82) 76-85 (80)

*NRC, 1994

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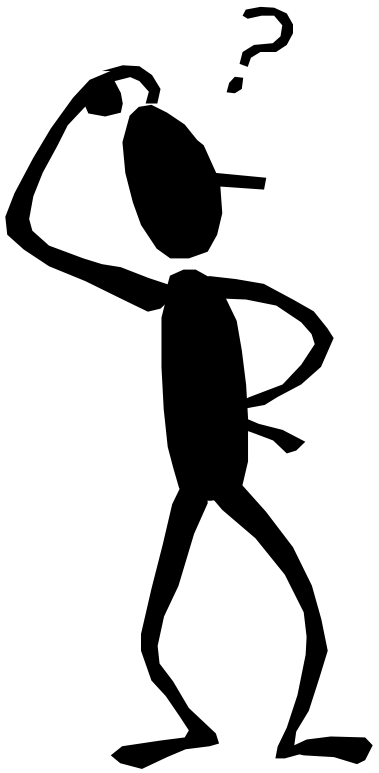

Tom Turkey Grower Diets	DDGS Level				
Digestible basis, 8-11 wks					
	Spec.	0%	10%	20%	30%
		---------- % ----------			
Corn		55.11	49.64	44.16	38.62
SBM		32.40	27.80	23.19	18.59
DDGS		**0**	**10**	**20**	**30**
PBM		**6**	**6**	**6**	**6**
Dicalcium phosphate		0.711	0.450	0.189	**0**
Calcium carbonate		0.614	0.794	0.975	1.116
DL-Methionine		0.201	0.182	0.164	0.145
L-Lysine · HCL		0.145	0.220	0.295	0.369
Threonine		0.050	0.050	0.050	0.050
Animal fat		**4.044**	**4.238**	**4.432**	**4.652**
Other					
Nutrients					
Protein (%)		22.7	23.0	23.3	23.6
Metabolizable energy (kcal/kg)	**3150**	**3150**	**3070**	**3150**	**3150**
Calcium (%)	**1.10**	**1.10**	1.10	1.10	1.10
Phosphorus, total (%)		0.84	0.84	0.84	0.85
Phosphorus, available (%)	**0.55**	**0.55**	**0.55**	**0.55**	**0.56**
Met + Cys (%)	**0.805**	**0.805**	**0.805**	**0.805**	**0.805**
Lysine (%)	**1.219**	**1.219**	**1.219**	**1.219**	**1.219**
Arginine (%)		1.348	1.306	1.263	1.221
Tryptophan (%)		0.212	0.200	0.187	0.174
Threonine (%)[1]	**0.768**	**0.768**	**0.768**	**0.768**	**0.768**

Tom Turkey Grower Diets

Digestible basis 8-11 wks of age	DDGS Level		Change in ingred. levels With DDGS		lbs per
	0	10	%	lbs per ton	100 lbs DDGS
Corn	55.11	49.64	-5.47	-109	-55
SBM	32.40	27.80	-4.61	-92	-46
DDGS	0.00	10.00	10.00	200.00	100
Dical	0.71	0.45	-0.26	-5.22	-2.61
Ca. carb.	0.61	0.79	0.18	3.62	1.81
DL-Methionine	0.20	0.18	-0.02	-0.37	-0.19
L-Lysine . HCL	0.15	0.22	0.07	1.50	0.75
Animal fat	4.04	4.24	0.19	3.88	1.94

Questions to Ask When Using DDGS

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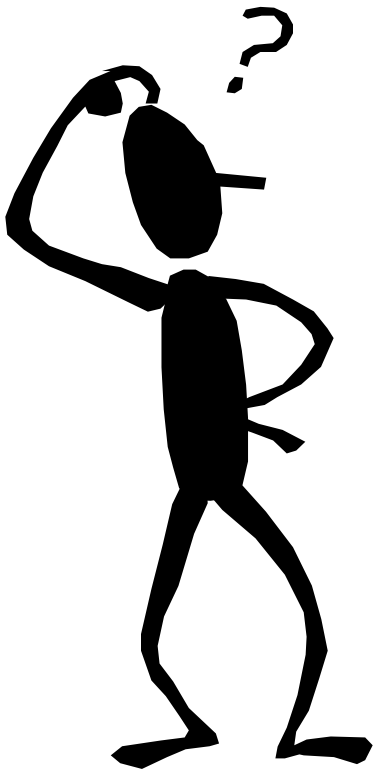


Feeding DDGS to Market Turkeys

- What are maximum feeding levels
  - 5, 10%
  - 20% or greater??

DDGs in Market Turkey Diets

- Early research prior to 1970's – turkey poults to 8 wks
- Levels of 10% similar or improved growth
- Levels of 20% increased feed/gain

Current Market Turkey Research

- Roberson, 2003
  - Hen turkeys – grow/finish diets
  - Isocaloric; digestible or total amino acids
- Noll ongoing
  - Tom turkeys – grow/finish diets (5-19 wks)
  - Formulation - isocaloric; digestible amino acids

DDGs and Turkey Hen Diets

DDGs %	BW 105 da, lb	F/G 75-105 da
Exp. 1		
0	18.81*	2.99
9	18.54	3.07
18	18.14	3.21
27	18.00	3.21
Exp. 2		
0	18.76	3.44
7	18.65	3.54
10	18.74	3.46

* Significant Linear Component From: Roberson, 2003

Market Tom Trials-Grow/Finish Diets (University of Minnesota)

Trial*	Trt	DDGs,%	BW, lb	F/G
1	Control	0	41.7	2.44
	DDGs	12-8	41.9	2.48
2	Control	0	42.2	2.64
	DDGs	11-8	42.2	2.65
3	Control	0	40.4	2.67
	DDGS	10	40.2	2.63

*Trial weeks of age; 1=5-19 wks; 2=8-19 wks; 3=11-19 wks

Levels above 10% (Trials 4 & 5)

Level (%)	BW 19 wks lbs
0	38.5
10	38.8
20	38.6

Level (%)	BW 19 wks lbs
0	38.4[a]
10	38.2[ab]
20	37.6[b]

Trial Differences

- Trial 4
  - Winter season
  - Normal protein
  - Low levels of MBM
- Trial 5
  - Spring/summer
  - Reduced protein
  - Low levels of MBM

Market Turkey Study 2006

- Diet Inclusion Levels
  - DDGS inclusion levels 0, 10, and 20%
  - PBM inclusion levels of 0, 8, and 12%

Methods

- *Diets*
  - Ingredients assayed for proximates and digestible amino acids
  - Formulated to provide 100% digestible thr and supplemented with met and lys
  - Isocaloric to control
  - Ratio of calcium to available phosphorus maintained at 2:1
  - Fed as mash
  - Experimental period 5 – 19 wks of age
- *Turkeys*
  - Male Large White, Nicholas strain
  - 10 birds/pen, 8 replicate pens/treatment

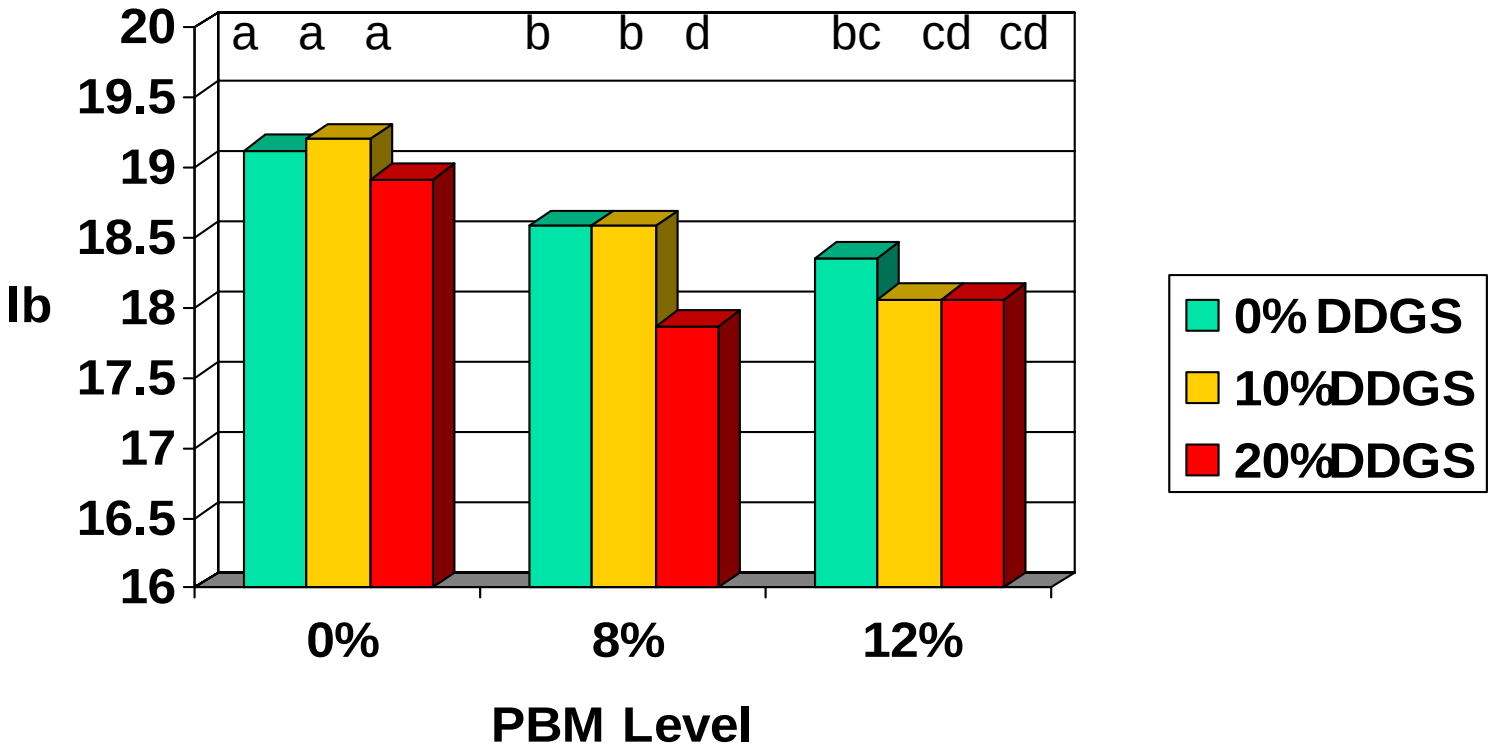
Diet Composition (%)
Selected Diets 5-8 wks of Age

Ingredient	Trt 1	Trt 3	Trt 5	Trt 9
Corn	46.62	55.10	33.60	41.24
SBM	43.05	29.62	35.36	22.07
PBM	0	12	0	12
DDGS	0	0	20	20
Dl-met	.18	.17	.155	.147
L-lys HCl	.112	.137	.289	.312
Animal fat	5.27	2.01	6.03	3.08
Dical	2.56	.03	2.259	-----

Results

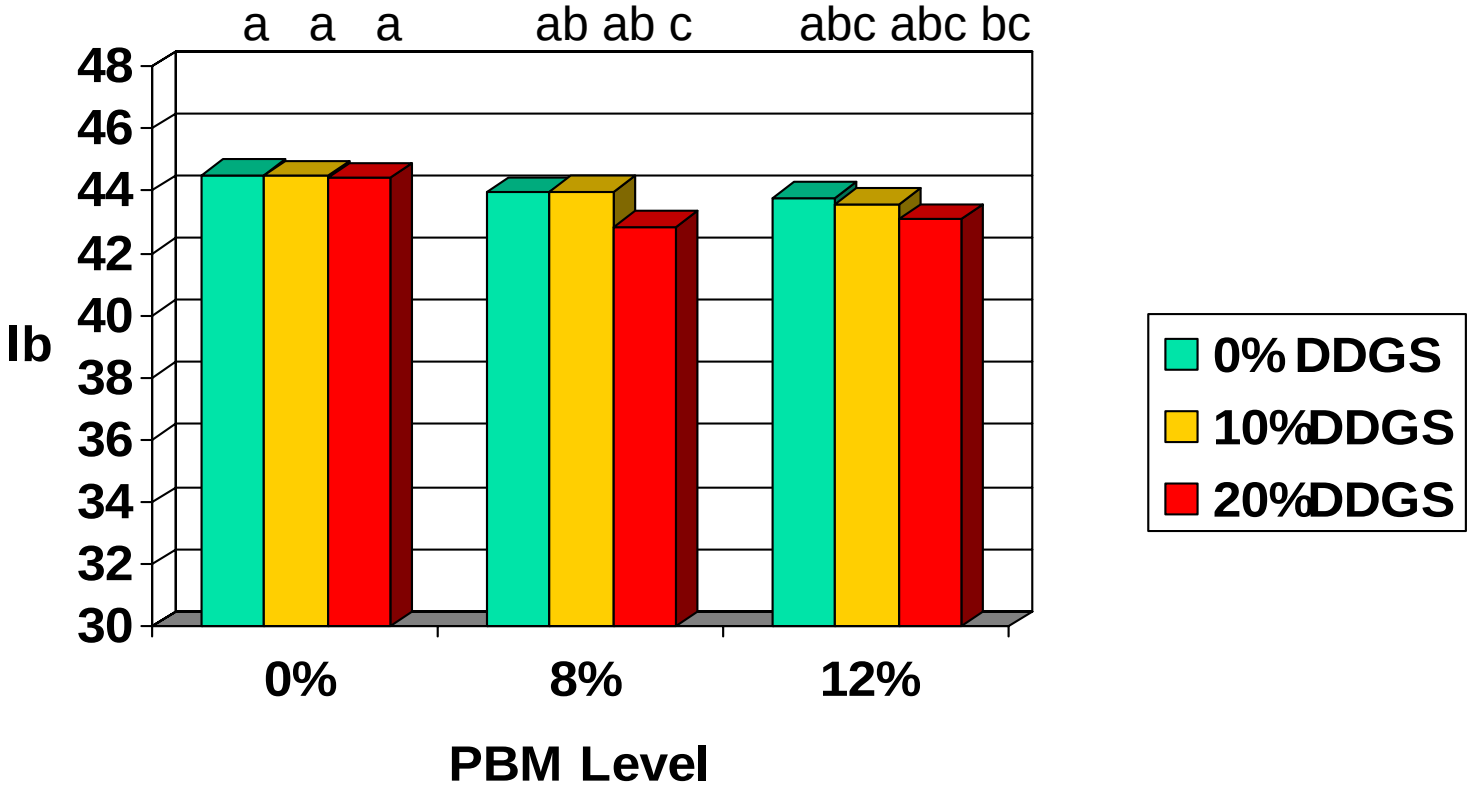
- Diet affected body weight and feed efficiency
- Response to DDGs was dependent on PBM level
  - body weight at 11 wks of age
  - feed efficiency (5-19 wks of age)

Body weight response to DDGS and PBM at 11 wks of age

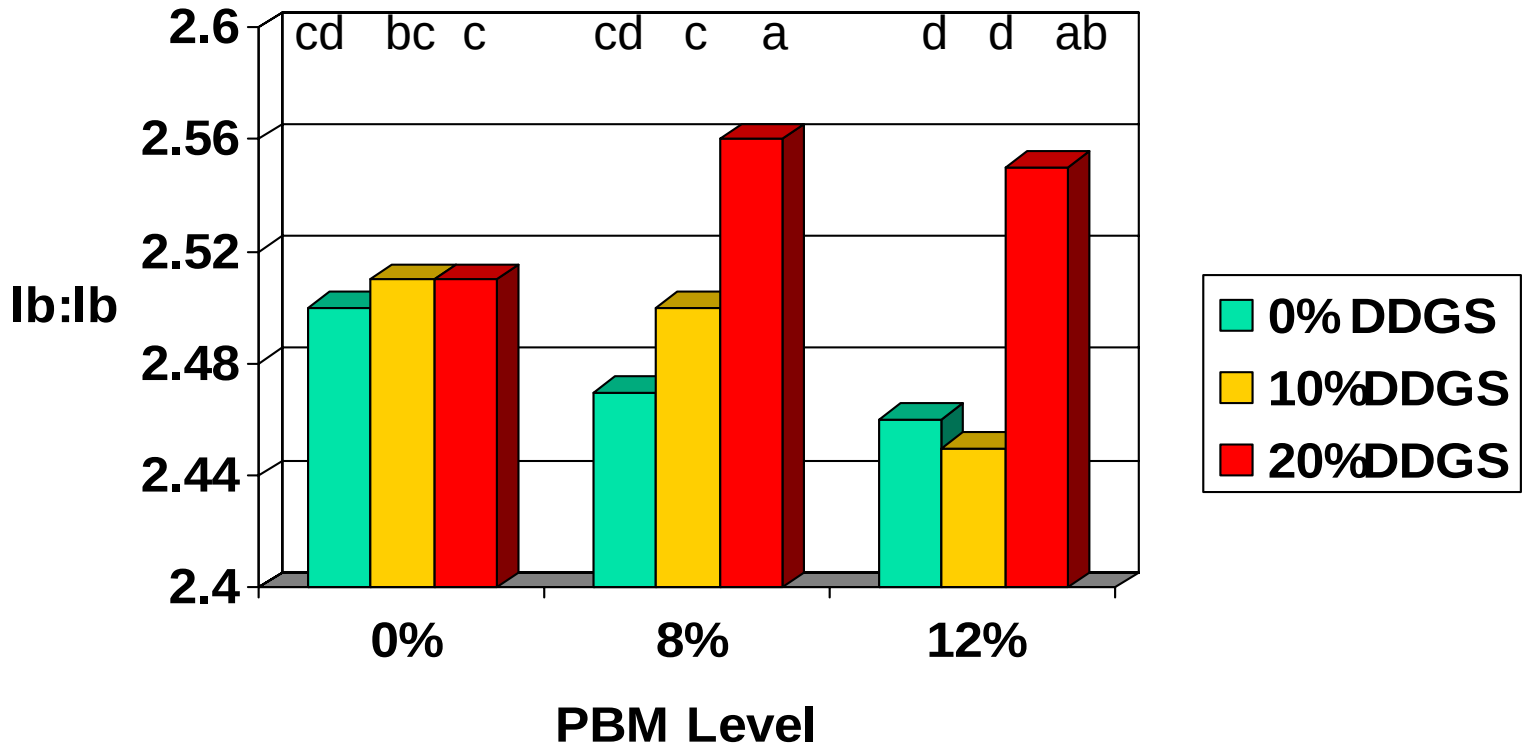


DDGS*PBM P<.023

Body weight response to DDGS and PBM at 19 wk BW



Interaction of DDGS and PBM on 5-19 wk F:G



DDGS x PBM (P<.02)

Summary

- In comparison to a corn-soy control diet, addition of PBM at 8 or 12% depressed body weight to 11 wks of age.
- In comparison to a corn-soy control diet, addition of 10 or 20% DDGS resulted in similar performance
- In comparison to a corn-soy control diet, addition of both PBM and 20% DDGS resulted in poorer performance, although performance of birds in the trial was very acceptable regardless of treatment.
  - Potential amino acid imbalance or deficiency (?)
  - Excess calcium & phosphorus (?)

Inclusion levels for turkeys

- Market Turkeys
  - Hens
    - Up to 10% (Roberson et al 2003)
  - Toms (Noll, 2006)
    - Up to 10% in summer season or lowered protein diets
    - Up to 20% in winter season or normal protein diets; or diets without animal protein

New Processes and New Distiller's Grains Co-Products

- Driven by:
  - Improve efficiency in ethanol production
  - Reduce fuel costs
    - Utilize solubles as liquid
      - Combustion
      - Extract - Biodiesel
  - Develop value added products

New Corn Processing Methods for Ethanol

- Examples of modified processes
  - Use of new technology to concentrate protein
    - Enzymes
    - Steam/acid processing
  - Fractionation – remove nonfermentables
    - Removal of bran and/or germ prior to fermentation
  - Removal of phosphorus
  - Removal of oil/solubles (fuel source)
  - Removal of fiber (elusieve)

New co-products

- High protein
  - Dakota Gold
- Corn germ, dehyd
  - Dakota Gold
- Others – research/development
  - NREL/Minnesota – high protein
  - University of Illinois
  - QTI (Glutenol)

Nutrient Content
Corn Co-Products

Nutrient	"Traditional" DDGS	High Protein DDGS	Corn Germ, Dehyd.
Dry matter, %	90.7	91.9	93.7
Crude protein, %	26.6	43	15.6
Crude fat, %	9.7	3.0	17.8
ME (poultry), kcal/lb	1297	1222	1775
NDF, %	23.6	18.7	22.8
Ash, %	4.1	1.8	5.4
Phosphorus, %	0.79	0.37	1.40
Lysine, %	0.83	1.19	.82
Methionine, %	0.52	0.85	0.26
Cystine, %	0.73	0.96	0.48
Threonine, %	1.01	1.63	.57

Summary

- Variability exists among sources of DDGS
  - To minimize:
    - Use color as a quick measure of quality
    - Get product from one source
    - New plants – time to produce a consistent product
    - Request current analyzed values or obtain analyses
    - Make sure product is correctly identified
      - DDGS vs DDG vs corn germ vs high protein DDG

Summary - Continued

- Incorporation of DDGs into turkey diets
  - Replaces corn and soy
  - Less supplemental methionine & dicalcium phosphate needed
  - Need more supplemental fat and lysine to keep energy and lysine levels

Recommendations for Use of DDGs

- Corn DDGs can be fed to market turkeys
  - Up to 10% for hens and 20% for toms
  - Lower levels in diets for young poultry (2-5%)
- Formulate with minimums for tryptophan and arginine in addition to those for lys, TSAA, and thr
- Formulate on basis of digestible amino acid content and adjust for higher phosphorus availability
- Lower maximum level of use in low density or low protein diets

University of Minnesota DDGS Webpage

- www.ddgs.umn.edu

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