Nutrient Content and Quality of DDGS

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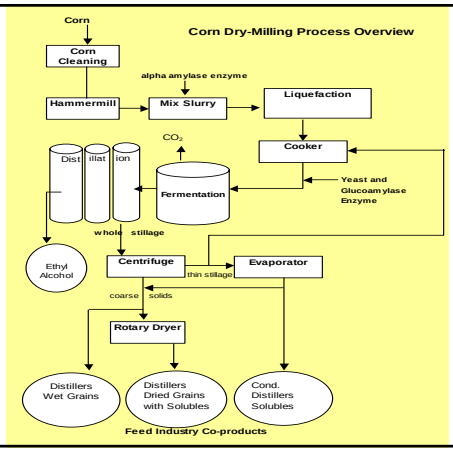
What is DDGS?

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



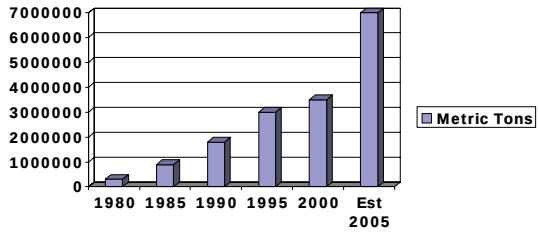
Dry-Milling Average Ethanol Yield Per Bushel (25.4 kg) of Corn

- Ethanol 10.2 liters
- DDGS 8.2 kg
- CO_2 8.2 kg

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

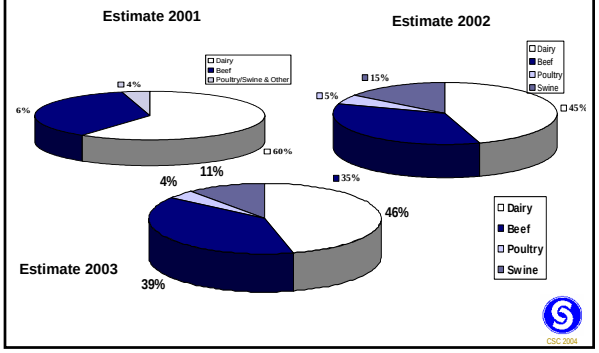
"New Generation" Ethanol Plants are Located in the Western "Corn Belt" of the U.S.

U.S. DDGS Production is Rapidly Increasing



Source: Commodity Specialists Company

U.S. DDGS Consumption

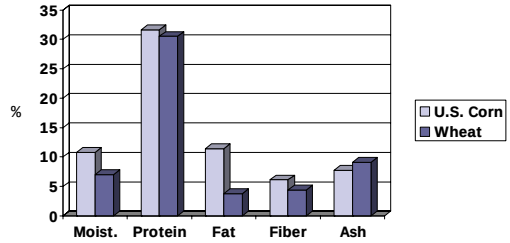


Comparison of Nutrient Composition (Dry Matter Basis) of "New Generation" DDGS to Corn Gluten Feed, Corn Gluten Meal, Corn Germ Meal, and Brewer's Dried Grains

	"New Generation" DDGS (UM)	Corn Gluten Feed (NRC)	Corn Gluten Meal (NRC)	Corn Germ Meal (Feedstuffs)	Brewer's Dried Grains (NRC)
Protein, %	30.6	23.9	66.9	22.2	28.8
Fat, %	*10.7*	3.3	3.2	1.1	7.9
NDF, %	43.6	37.0	9.7	No data	52.9
DE, kcal/kg	*4011*	3322	4694	No data	2283
ME, kcal/kg	*3827*	2894	4256	3222	2130
Lys, %	0.83	0.70	1.13	1.00	1.17
Met, %	0.55	0.39	1.59	0.67	0.49
Thr, %	1.13	0.82	2.31	1.22	1.03
Trp, %	0.24	0.08	0.34	0.22	0.28
Ca, %	0.06	0.24	0.06	0.33	0.35
Available P, %	*0.80*	0.54	0.08	0.17	0.21

U.S. "Golden" Corn DDGS Wheat DDGS from Minnedosa, MB

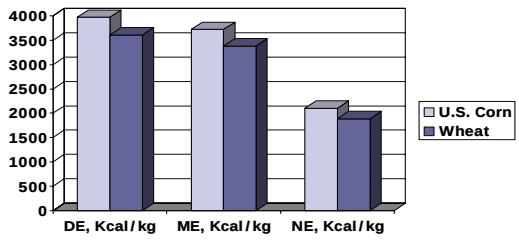
Comparison of Proximate Analysis of U.S. Golden Corn DDGS to Canadian Wheat DDGS (100% Dry Matter Basis)



U.S. Corn = average of values obtained from samples from 9 "New Generation" dry-mill ethanol plants (Shurson and Whitney, 2004)

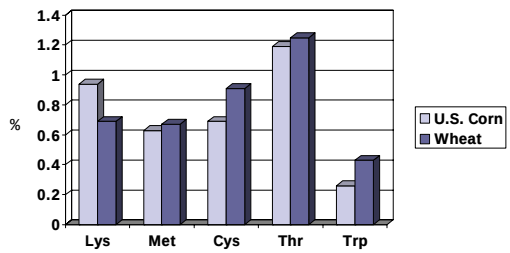
Wheat = actual analyzed values of DDGS produced by Mohawk, Minnedosa, MB

Comparison of Calculated DE, ME, and NE Values for Swine Between U.S. Golden Corn DDGS and Wheat DDGS (100% Dry Matter Basis)



U.S. Corn = average of values obtained from samples from 9 "New Generation" dry-mill ethanol plants (Shurson and Whitney, 2004)
Wheat = actual analyzed values of DDGS produced by Mohawk, Minnedosa, MB
DE and ME calculated using equations from Noblet and Perez (1993)
NE calculated using equation from Ewan (1989)

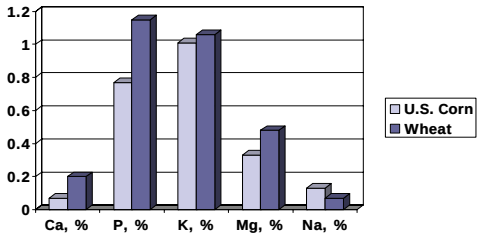
Comparison of Amino Acid Analysis of U.S. Golden Corn DDGS to Wheat DDGS (100% Dry Matter Basis)



U.S. Corn = average of values obtained from samples from 9 "New Generation" dry-mill ethanol plants (Shurson and Whitney, 2004)

Wheat = actual analyzed values of DDGS produced by Mohawk, Minnedosa, MB

Comparison of Macro-mineral Analysis of U.S. Golden Corn DDGS to Wheat DDGS (100% Dry Matter Basis)



U.S. Avg. = average of values obtained from samples from 9 "New Generation" dry-mill ethanol plants (Shurson and Whitney, 2004)

U.S. – SD = actual analyzed values of DDGS produced by a South Dakota ethanol plant that was exported to Taiwan

China Act = actual analyzed values of a sample of Chinese DDGS obtained from Taiwan

Samples of Golden Corn DDGS from Various U.S. Ethanol Plants

VeraSun - Aurora, SD | CVEC - Benson, MN | Al-Corn - Claremont, MN | MGP – Lakota, IA

CMEC - Little Falls, MN | Agri-Energy - Luverne, MN | LSCP - Marcus, IA | DENCO – Morris, MN

Corn DDGS from Gimli, MB — Corn DDGS from Chatham, ON

Corn DDGS Color and Smell are Indicators of Digestibility for Monogastrics

- Color varies among sources
  - ranges from dark to golden **(Cromwell et al., 1993)**
  - golden color of corn DDGS is correlated with higher amino acid digestibility in swine and poultry
- Smell varies among sources
  - ranges from burnt or smoky to sweet and fermented **(Cromwell et al., 1993)**
  - golden DDGS has a sweet, fermented smell
  - smell may affect palatability

"Old Generation" vs. "New Generation" DDGS

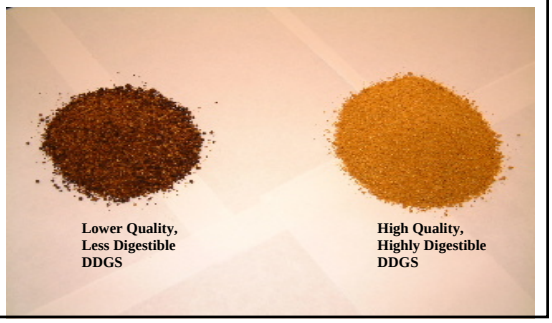
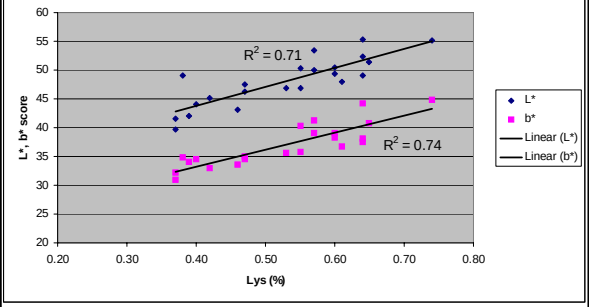
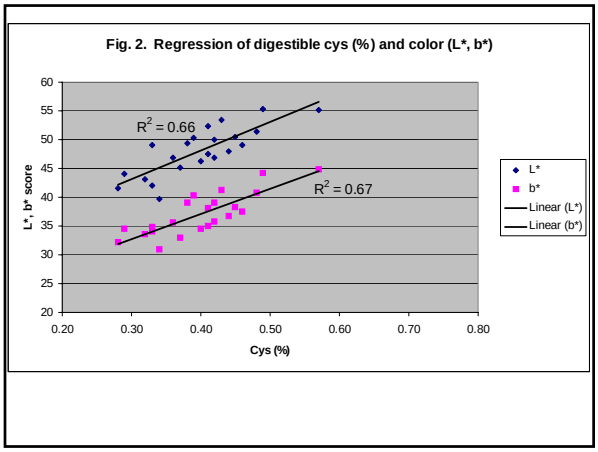
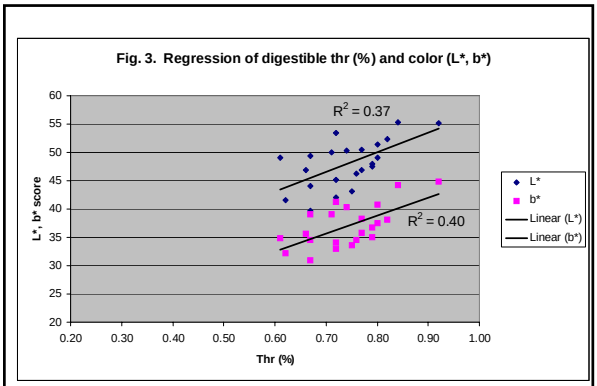


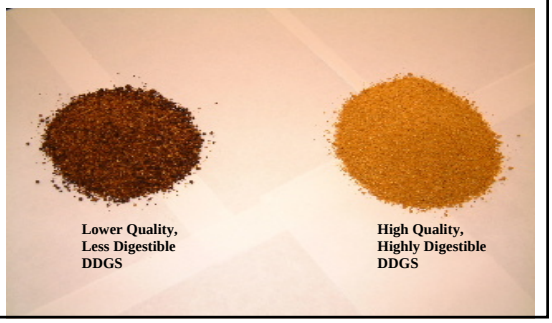
Fig. 1. Regression of digestible lys (%) and color (L*, b*)







"Old Generation" vs. "New Generation" DDGS



Proximate Analysis of "New Generation"DDGS (100% Dry Matter Basis)

Nutrient	"New Generation" DDGS
Dry matter, %	89.2
Crude protein, %	31.6
Fat, %	11.5
Crude fiber, %	6.2
Ash, %	7.8
NFE, %	42.8
ADF, %	11.2

Physical Characteristics of "New Generation" DDGS

- Bulk density (16 "new generation" plants)
  - 35.7± 2.79 lbs/ft^3
  - Range 30.8 to 39.3 lbs/ft^3
- Particle size (16 "new generation" plants)
  - 1282± 305 microns
  - Range 612 to 2125 microns

Quality Assessment of "New Generation" DDGS

- NIR
- Smell
- Color
- Mycotoxins
- Fat stability

NIR Calibrations for DDGS

Nutrient	R	Rmsep, %	R^2	CV, %
Lysine	0.89	0.064	.79	16.2
Methionine	0.81	0.044	.66	14.2
Threonine	0.73	0.046	.53	6.2
Energy	0.87	37	.76	1.9

R = correlation between actual and predicted values
Rmsep = prediction error
R^2 = proportion of the total variation explained by calibrations
CV, % = coefficient of variation among DDGS samples

DDGS Color and Smell

- Color varies among sources
  - ranges from dark to golden **(Cromwell et al., 1993)**
  - "new generation" DDGS is more golden and color is less variable
  - golden color is correlated with higher amino acid digestibility in swine and poultry
- Smell varies among sources
  - ranges from burnt or smoky to sweet and fermented **(Cromwell et al., 1993)**
  - "new generation" DDGS has a sweet, fermented smell
  - smell may affect palatability

Mycotoxins

- Risk of mycotoxin contamination in "new generation" DDGS is very low
  - Poor quality corn = poor ethanol yields
  - Corn supplied to ethanol plants is produced locally
  - Corn produced in upper Midwest is has a low risk for mycotoxins
- Must use thin layer chromatography (TLC) or HPLC for testing mycotoxins in DDGS
  - ELISA and other methods result in false positives

Fat Stability of DDGS

- Limited data
- Mexico
  - DDGS monitored during transit and storage for 16 weeks in a commercial feed mill in Jalisco, Mexico
    - Temperature ranged from 2 to 28 degrees C
    - Average high temperature 25 degrees C
    - Average low temperature was 8.4 degrees C
  - No rancidity was detectable

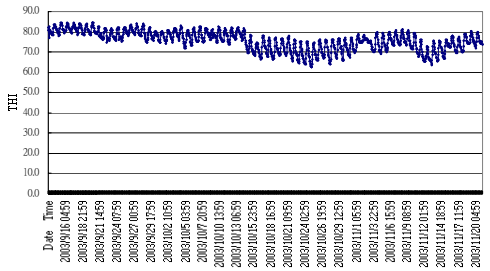
Fat Stability of DDGS in Taiwan

- Study conducted at Lin-Fong-Ying Dairy Farm
  - a commercial dairy farm located about 20 km south of the Tropic of Cancer
  - DDGS was shipped from Watertown, SD to Taiwan in a 40 ft. container
  - upon arrival in Taiwan, DDGS was re-packaged in 50 kg feed bags with a plastic lining
  - DDGS bags were stored in a covered steel pole barn for 10 weeks during the course of the dairy feeding trial

Dr. Yuan-Kuo Chen discussing DDGS sampling procedures from storage bags with his research assistant.

Inside of the covered, steel pole barn used to store bags of DDGS and other forage and feed ingredients at LFY Dairy.

Temperature-Humidity-Index (THI) During the Taiwan DDGS Fat Stability Trial



Fat Stability of DDGS in Taiwan

Analysis	Week 1	Week 10
Peroxide value, mEq/kg	0.70	0.60
Free fatty acids, % as oleic	11.2	16.2

Peroxide values < 5 mEq/kg are considered acceptable for fat quality and there is no oxidative rancidity.

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