Energy determination of corn co-products fed to broiler chicks from fifteen to twenty-four days of age and use of composition analysis to predict AME_n

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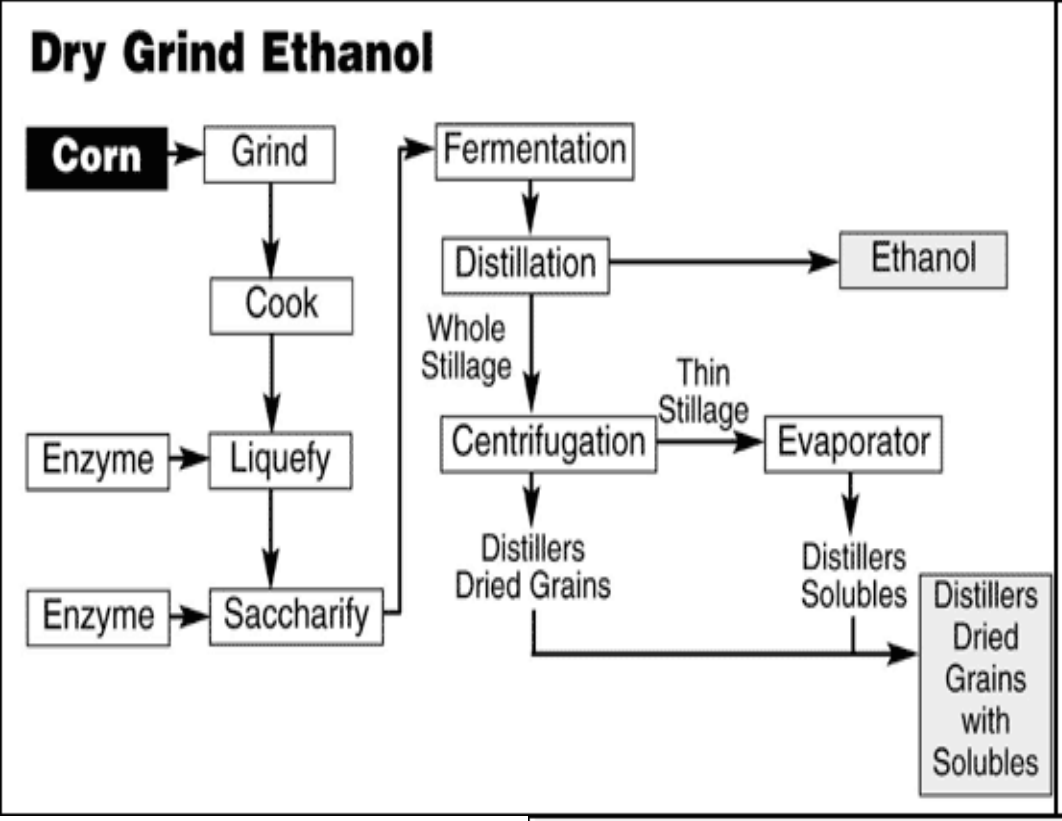
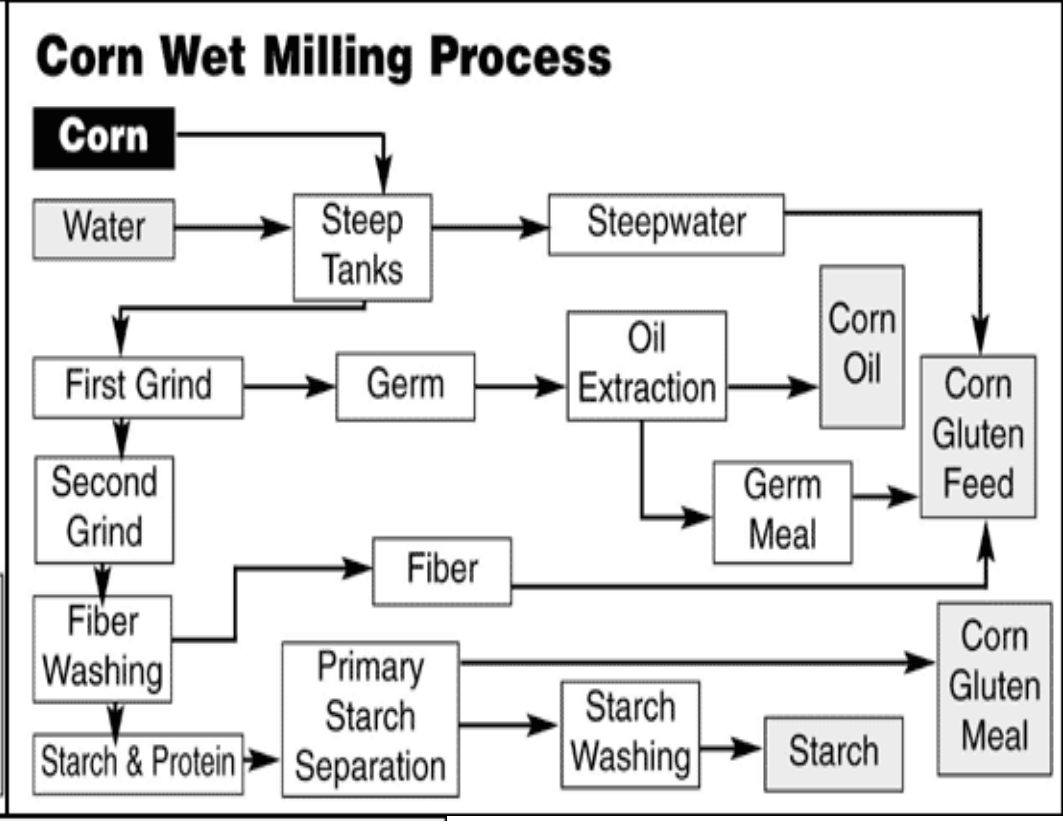
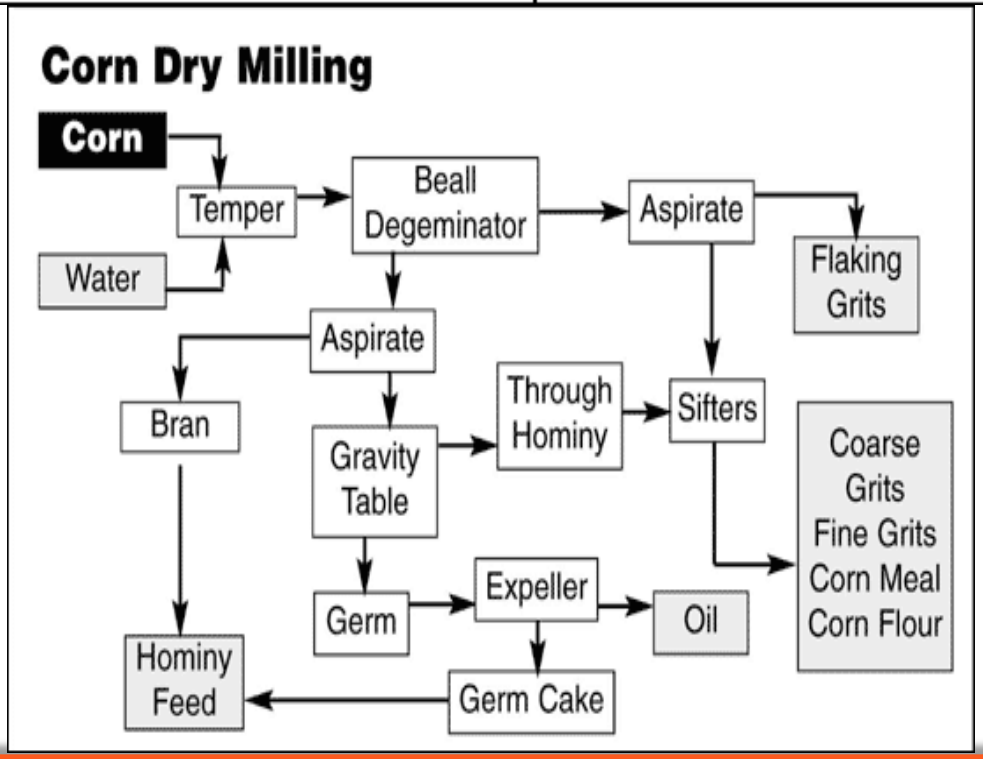
Introduction

- **10.6 billion gallons of ethanol were produced in the U.S. during 2009.**
  - **(Renewable Fuels Association)**

- **As corn-milling technologies increase efficiency, corn co-products continue to evolve.**


Dry Grind Ethanol
Corn
Grind
Cook
Enzyme
Liquefy
Enzyme
Saccharify
Fermentation
Distillation
Ethanol
Whole Stillage
Thin Stillage
Centrifugation
Evaporator
Distillers Dried Grains
Distillers Solubles
Distillers Dried Grains with Solubles


Corn Wet Milling Process
Corn
Water
Steep Tanks
Steepwater
First Grind
Germ
Oil Extraction
Corn Oil
Corn Gluten Feed
Second Grind
Germ Meal
Fiber
Fiber Washing
Primary Starch Separation
Corn Gluten Meal
Starch & Protein
Starch Washing
Starch


Corn Dry Milling
Corn
Temper
Water
Beall Degeminator
Aspirate
Flaking Grits
Aspirate
Bran
Gravity Table
Through Hominy
Sifters
Coarse Grits
Fine Grits
Corn Meal
Corn Flour
Germ
Expeller
Oil
Hominy Feed
Germ Cake

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Introduction

- **Researchers have developed ME prediction equations for poultry and swine based on composition analysis.**
  - **(Noblet et al., 1993; Fairbarn et al., 1999; Batal and Dale, 2006; Pedersen et al., 2007)**

- **ME prediction equations for corn co-products may be useful for broiler nutritionists.**

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Objective

- **Develop an equation to predict AME_n based upon ingredient chemical composition of 15 corn co-products in broiler chicks**

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Co-Products

- **Fifteen co-products were obtained from corn wet-milling and dry-grind plants throughout the United States.**
  - **DDGS (6)**
  - **HP-DDG (2)**
  - **Gluten meal**
  - **Dehulled, degermed corn**
  - **Corn germ meal**
  - **Dehydrated corn germ (2)**
  - **Corn bran**
  - **Gluten feed**

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Nutrient Variability of Corn Co-Products

Co-products	CP (%)	Fat (%)	Ash (%)	NDF (%)
DDGS	26.5-34.7	3.2-12.5	4.2-5.4	30.2-51.0
HP-DDGS	43.8-57.5	2.9-4.1	1.1-2.1	32.0-43.5
Corn germ meal	23.6	2.38	2.7	61.05
Corn gluten meal	66.3	1.34	1.1	12.3
Corn gluten feed	24.3	2.7	6.8	42.7
Dehulled, degermed corn	8.3	0.2	0.5	4.3
Corn bran	15.2	9.7	5.3	25.2
Dehydrated corn germ	17.5-17.6	17.9-18.4	6.2-6.5	18.8-27.4

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Basal Diet

Ingredient	(%, as-is)
Corn	62.92
Soybean Meal	32.88
Dicalcium phosphate	1.72
Calcium carbonate	1.13
Sodium chloride	0.52
DL-Met 99%	0.28
Other	0.55

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Materials and Methods

- Nineteen hundred and twenty Ross 708 chicks were used in three trials (640 birds per trial) from 1 to 24 d of age.

- From 15 to 22 d of age, birds were randomly assigned to one of 16 treatments. Treatments consisted of 85% of the basal diet and 15% of the test ingredient.

- Energy balance assay was conducted using the difference method from 22 to 24 d of age.

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Husbandry Practices

- **Birds were housed in Petersime battery cages.**
- **Access to feed and water was provided *ad libitum.***
- **A 23L:1D lighting schedule was used.**
- **Temperatures ranged from 33º C to 27º C.**

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Excreta Collection

- A 48 h collection period was conducted from 22 to 24 d.
- Excreta was dried and ground.
- Dried samples were analyzed for gross energy and nitrogen content.

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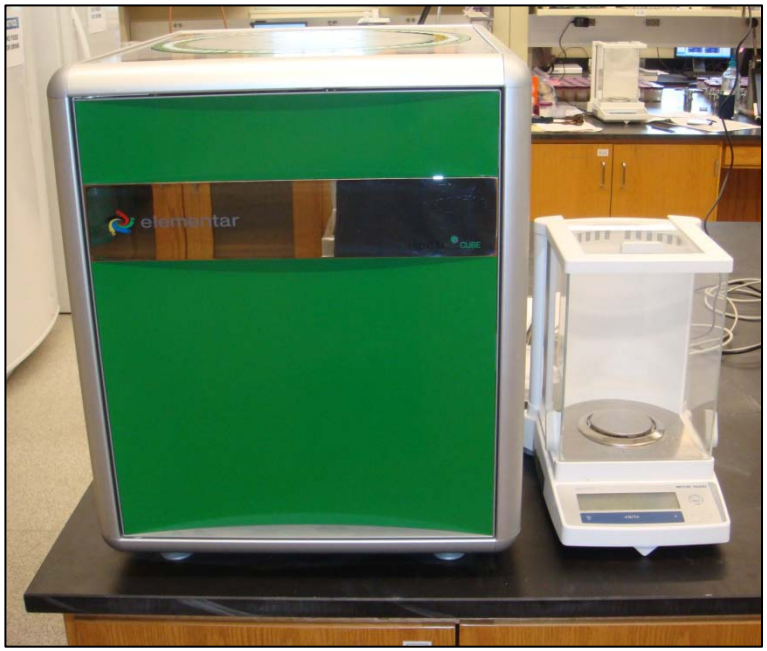
Chemical Analysis

- **Measurements**
  - **DM, GE, CP, crude fat, crude fiber, starch, ash, total dietary fiber, NDF, ADF, and hemicellulose**
    - **Hemicellulose determined by NDF – ADF**



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Calculation of AME_n

- AME_n intake = (GE_{intake} – $GE_{excreta}$) – (8.73 * Retained N)
- AME_n intake of co-product = AME_n intake of the test diets – AME_n intake of the basal portion
- AME_n of the basal = AME_n of control diet (85% basal + 15% dextrose) – 3,640 kcal ME/kg of dextrose
  - (Hill and Anderson, 1958; Sell et al., 2001)
- AME_n, kcal/kg = AME_n intake of the co-product ÷ feed intake

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Statistics

- Three replicate trials were repeated over time to generate 12 replicates per treatment.
- Randomized complete block design
  - Pen used as the experimental unit
- SAS PROC CORR
- SAS PROC REG
  - Stepwise selection was used to determine significant variables on the prediction of AME_n.

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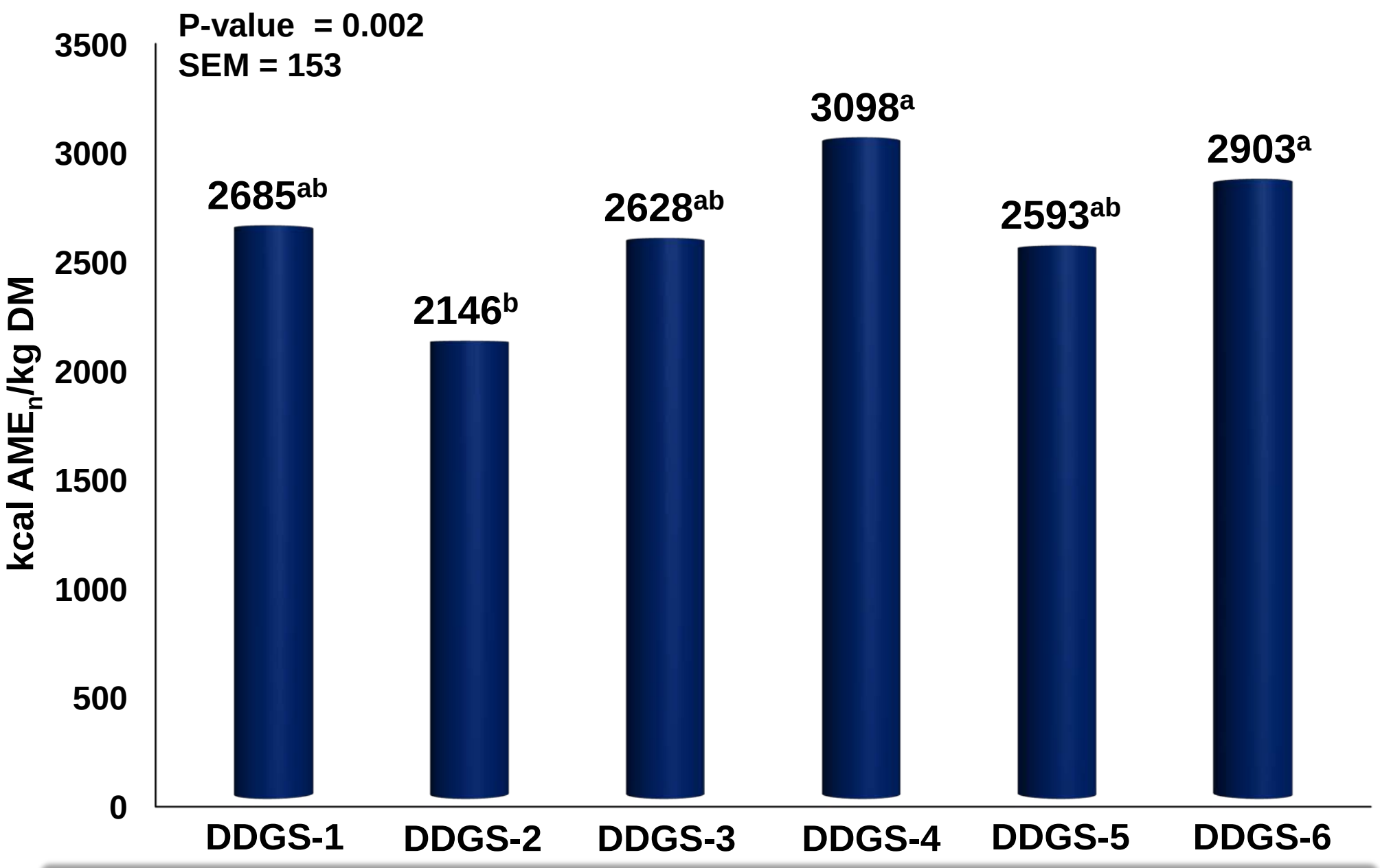
AME_n of Corn DDGS Products



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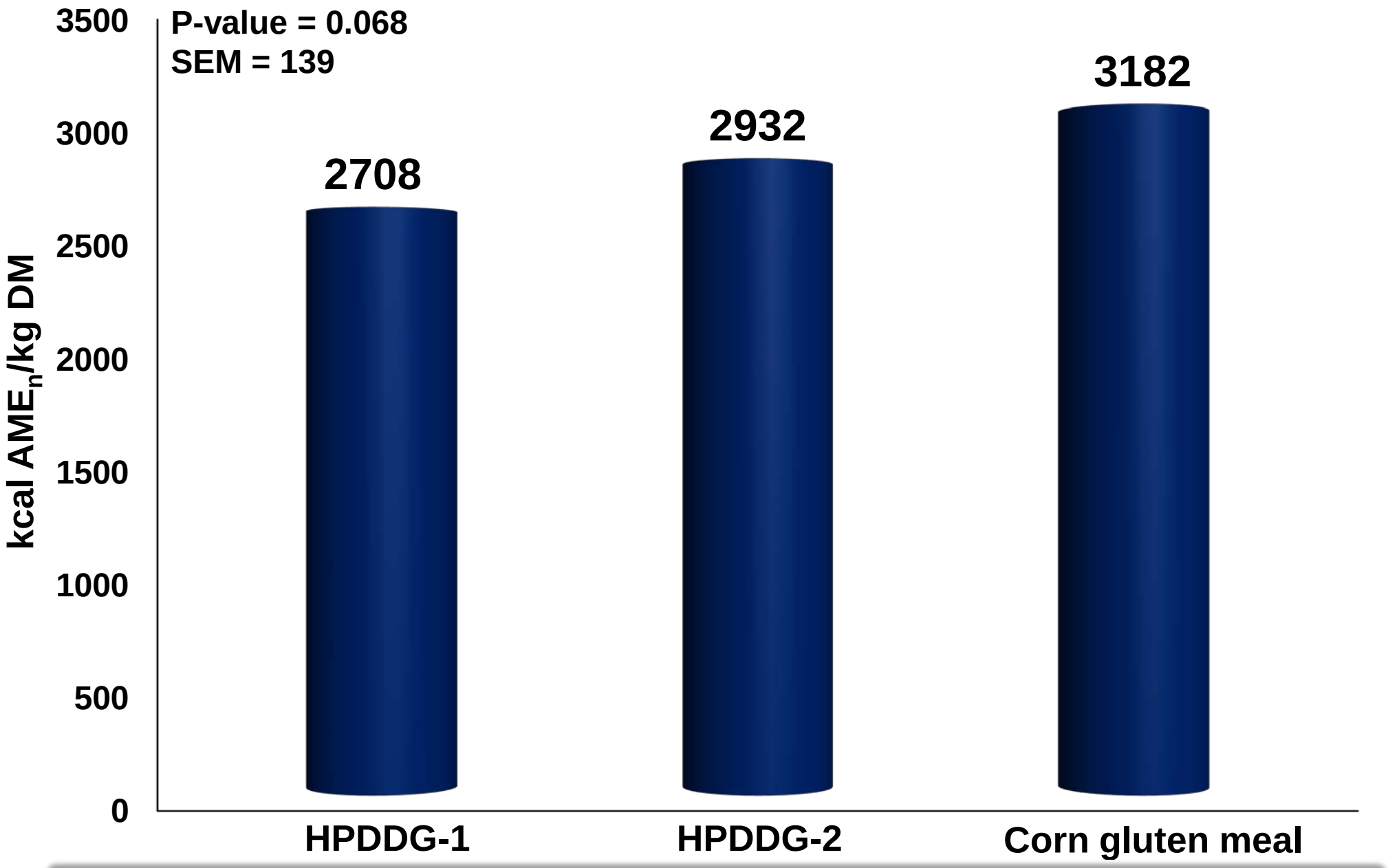
AME_n of High Protein Corn Products



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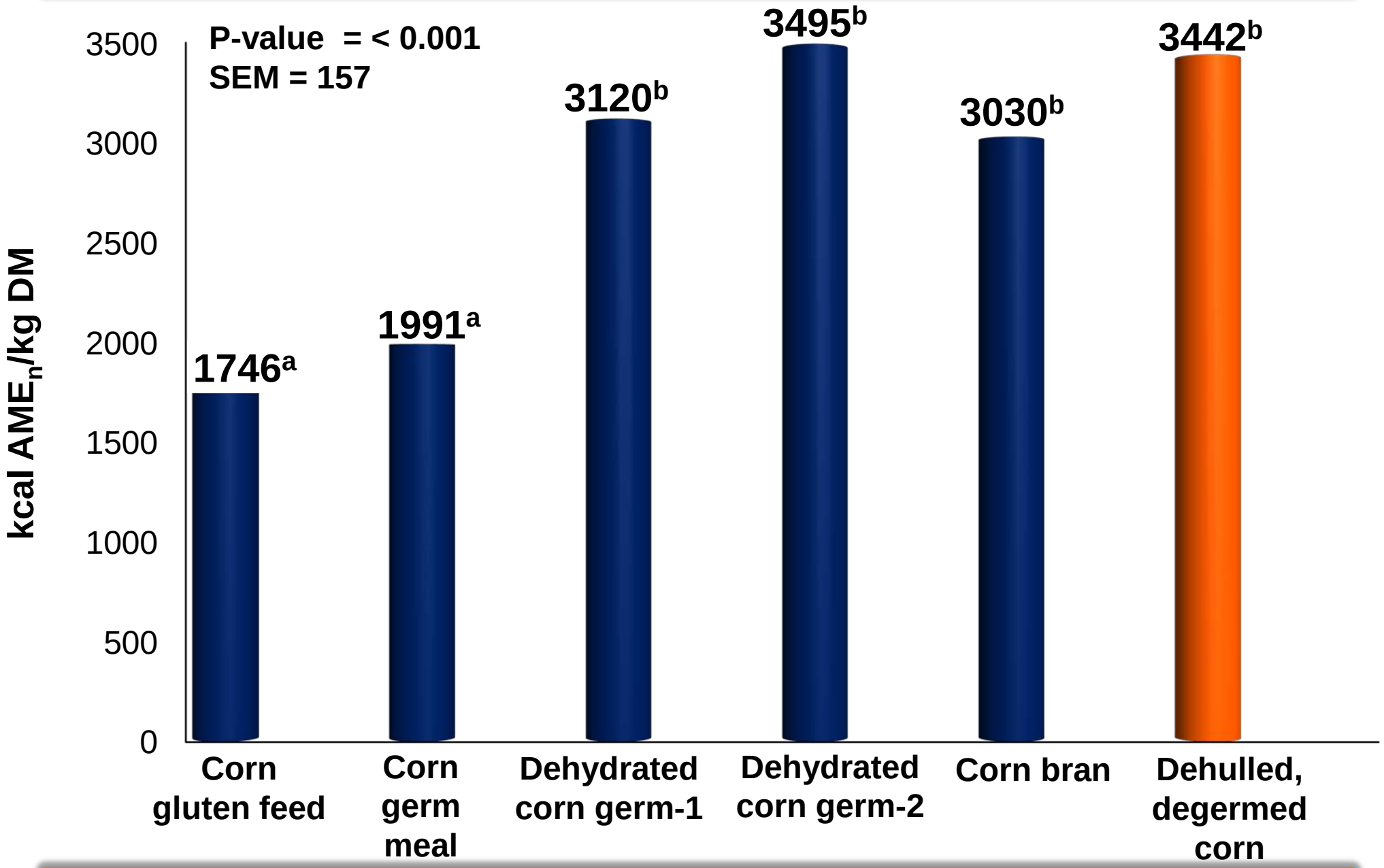
AME_n of Fibrous Corn Products



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Regression Equation

AME_n kcal/kg DM =

3,517 + (46.02 × % crude fat DM) - (33.27 × % hemicellulose DM) – (82.47 × % ash DM)

	Regression coefficients				Statistical parameters	
AMEn Equation	Intercept	Hemi-cellulose	Crude Fat	Ash	SD	R^2
1	3635	-37.72	-	-	280	0.71
Estimate P value	0.01	0.01	-	-	-	-
2	3382	-36.99	29.55	-	221	0.84
Estimate P value	0.01	0.01	0.01	-	-	-
3	3517	-33.27	46.02	-82.47	191	0.89
Estimate P value	0.01	0.01	0.01	0.04	-	-

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Regression Equation

AME_n kcal/kg DM =

– 156 – (24.26 × % NDF DM) + (1.05 × % GE DM) – (11.36 × % CP DM) + (6.69 × % Starch DM)

	Regression coefficients					Statistical parameters	
AMEn Equation	Intercept	NDF	GE	Crude protein	Starch	SD	R^2
1	3733	-28.79	-	-	-	294	0.69
Estimate P value	0.01	0.01	-	-	-	-	-
2	1412	-30.41	0.46	-	-	247	0.80
Estimate P value	0.15	0.01	0.03	-	-	-	-
3	-194	-30.17	0.85	-12.89	-	204	0.87
Estimate P value	0.84	0.01	0.01	0.03	-	-	-
4	-156	-24.26	1.05	-11.36	6.69	190	0.90
Estimate P value	0.23	0.01	0.01	0.04	0.13	-	-

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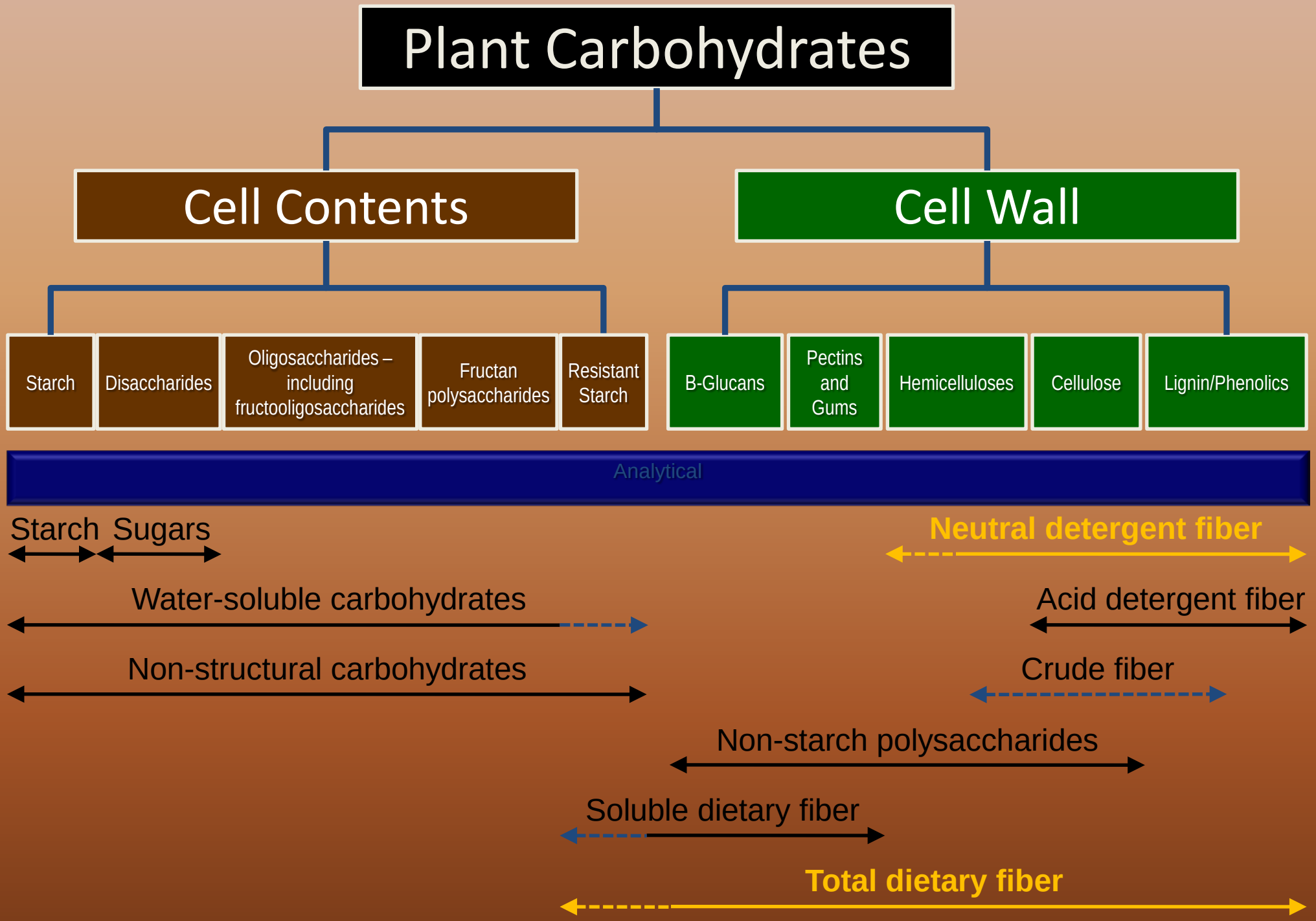
Summary

- Wide variability exists among corn co-products produced from dry and wet milling plants
- Based on multiple linear regression, best predictors of AME_n are crude fat, hemicellulose, and ash.
- Removing hemicellulose from the model, the best predictors of AME_n are NDF, GE, crude protein, and starch.



Fahey, pc

Dashed lines indicate that recovery of included compounds may be incomplete