ADDING DRIED DISTILLERS GRAINS TO SWINE DIETS AFFECTS FEED PREFERENCE

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Summary

Three studies were conducted to evaluate the effects of dried distillers grains with solubles (DDGS) on feed intake in growing pigs. In all experiments, pigs were housed in 10.5 × 10.3 ft pens with four 1-hole feeders in each pen to allow pigs to choose from four dietary treatments. In Experiment 1, we evaluated the influence of DDGS drying method on palatability of DDGS. Diets were a control corn soybean-meal diet or a corn soybean-meal diet with 30% DDGS from one of two drying techniques (plant dried, hand dried, or not dried). Overall, ADFI was less ($P<0.05$) for all DDGS drying methods than for the corn-soybean control. For Experiment 2, we compared the influence of DDGS grain source on feed intake. We compared differences between a corn-soybean meal diet and corn-soybean meal diets with 30% DDGS from two corn facilities or one milo facility. Overall, adding 30% DDGS from all sources reduced ($P<0.05$) ADFI below that of corn-soybean meal diets. In Experiment 3, we used gas chromatography/mass spectrometry (GC/MS) to identify compounds found in DDGS sources from Experiment 2 to determine if any specific compounds are responsible for negative effects on feed intake. We added Furfural, γ-Butyrolactone, and Phenyl ethyl alcohol to corn-soybean meal diets at twice the concentration found in diet with 30% DDGS. We fed a control corn soybean-meal diet or corn soybean-meal with 20 ppm of each compound per ton of complete feed. The addition of each individual compound had no effect ($P>0.55$) on feed intake. These studies illustrate that pigs prefer corn-soybean diets to diets containing DDGS. The decrease in palatability seems to increase with increasing amounts of dried distiller grains. Although the nutrient content of DDGS make it an attractive ingredient for swine diets, palatability problems may affect pig performance, even when DDGS is included at low rates in the diet.

(Key Words: Pigs, Feed Intake, DDGS.)

Introduction

Studies have shown that distillers dried grains with solubles (DDGS) has larger nutrient values than previously reported by the NRC (1998). These studies have shown that the ME of DDGS is similar to the ME of corn. With an increase in the number of new ethanol plants, which produce DDGS as a co-product, the availability and attractiveness for use of DDGS swine diets also has increased. Because of the low lysine and high fiber content, compared with other ingredients typically fed to pigs, DDGS traditionally has been widely fed to ruminants. New processing techniques and better quality control may have lead to a better and more consistent nutrient profile of DDGS.

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Several growth studies have shown that feed intake is less for pigs fed diets containing DDGS, compared with that of pigs fed diets based on corn soybean meal. Many production systems and feed companies that currently use DDGS in diet formulations limit the inclusion to less than 15% of the diet. Higher concentrations are seldom used because of reductions in feed intake. Thus, the rate of inclusion for DDGS in swine diets may be limited due to palatability problems. In the 2004 Swine Day Report of Progress, we reported that increasing amounts of DDGS in the diet caused a linear reduction in feed preference, and that the decreased palatability could not be overcome by including a feed flavor in the diet. The objective of these studies was to further evaluate the effects of source of DDGS on feed intake in growing pigs.

Procedures

General. The nutrient compositions of ingredients as provided by NRC (1998) were used in diet formulation, except for compositions of DDGS sources, which were determined by laboratory analysis (Table 1). All experiments were conducted at the Kansas State University Swine Teaching and Research Facility. Each pen was 10.5 × 10.3 ft, with completely slatted flooring, and contained two nipple waterers. Environmental temperature was maintained by using mechanically assisted ventilation and heaters. Four individual 1-hole self feeders (Pride of the Farm, Houghton, IA) allowed four treatment diets to be available at all times in each pen. Feeders were rotated clockwise one position every morning and evening for the entire length of each study. Feeder weights were obtained every 7 d to determine ADFI; pig weights were taken at the beginning and conclusion of the trials for calculation of growth performance.

Experiment 1. The process of drying distiller's grains has improved in recent years with development of new technology and dryer design. But dried grains can still remain in the dryer for extended periods of time and also can encounter very high temperatures. During the drying process, various volatile organic compounds are released or combined to generate various flavor components. These drying conditions may create an undesirable flavor for swine. Therefore, the purpose of this study is to evaluate different drying techniques on palatability of DDGS.

A total of 187 pigs (PIC L327 x 1050) with an initial weight of 49.4 ± 1.8 lb with four pens of barrows and gilts each and 25 pigs per pen and contained four feeders. Treatments were a control corn soybean-meal diet, corn soybean-meal with 30% DDGS from one of two drying techniques, and a fourth treatment using undried, wet product. All DDGS used in this study originated from the same batch of DDGS from a single, new dry-grind ethanol plant (Source 6). Drying techniques included plant-dried DDGS from a plant which used two drum dryers (*ICM*, Wichita, KS) and a temperature of 828°F. A second drying treatment consisted of obtaining wet DDGS from the same batch, taking it to the KSU Animal Science feed mill, and drying it in Model 982a rotary cooler (California Pellet Mill (CPM), Crawfordsville, IN). The wet distillers grain was cycled fourteen times through the cooler with indirect heat, providing an average temperature of 144°F during the process and resulting in product dried to 82.8% DM. The diets were balanced for the same amount of DDGS dry matter, total Ca, P, and lysine (Table 2).

Experiment 2. We conducted a 19-d study to evaluate feed intake when DDGS was added at 30% to corn-soybean meal diets from three different sources. Corn DDGS was obtained from two new Midwestern dry-grind ethanol facilities within a three-week period. In addition, we wanted to measure the differences in feed intake between corn and milo DDGS diets. Milo DDGS (Source 7) was obtained from an ethanol plant that used milo as grain stock for ethanol production. We used 112 pigs (PIC L327 x 1050) with an initial weight of 69.9 ± 1.5 lb to determine if feed intake was different between a corn-soybean meal diet (Table 3) and corn-soybean meal diets with 30% DDGS from one of three different sources (Source 1, 6, and 7). There were 7 pens with 16 pigs per pen.

Experiment 3. Because of differences in intake between DDGS sources in Experiment 2, we wanted to identify specific compounds within each source that may contribute to decreased feed intake. Therefore, samples from Experiment 2 and other DDGS sources were analyzed by using gas chromatography/mass spectrometry (GC/MS) analysis to identify and quantify compounds within each DDGS source.

Our hypothesis was that these compounds may be responsible for the off flavor or taste that pigs experience when consuming diets with DDGS. Because of the trend of decreasing intake from Sources 1, 6, and 7, we plotted the percentage intake of each source from the control total feed intake within the pen. Using the results from the GC/MS analysis, we also plotted the concentration of each compound as a percentage of the total compounds present in each DDGS sample. Plotting both percentage feed intake for each source and compounds from each source on same graph revealed that three compounds were common between all samples and followed a general trend that may be correlated with depression in feed intake (Figure 1). From this analysis, we selected the three compounds (Furfural, *γ*-Butyrolactone, and Phenyl ethyl alcohol) for evaluation of their effects on feed intake when added to a control corn-soybean meal diet at twice the concentration that would be found in a diet with 30% DDGS. Furfural is an aldehyde that commercially is obtained by distilling acid-digested corn cobs, oat hulls, rice hulls, or cottonseed hulls. γ-Butyrolactone is a hygroscopic, colorless liquid that is obtained by the dehydrogenation of 1,4-butanediol and has a slight caramel sweet odor. Phenyl ethyl alcohol is a colorless liquid, with a faint odor of roses, that occurs naturally in many plants. For compound identification, we used solid-phase miroextraction to obtain extracts that were then analyzed by using gas chromatography. Analysis identified three compounds (Furfural, *γ*-Butyrolactone, and Phenyl ethyl alcohol) common between the three DDGS sources from Experiment 2.

To determine if a specific compound was responsible for negative impact on feed intake, we added twice the estimated concentration of each compound to corn-soybean meal diets. Compounds were prepared by thoroughly mixing 1/5 of the desired concentration into 1 lb of corn. This process was repeated five times. Next, we combined the 5 batches and mixed them to create a compound-corn mixture weighing 5 lb. The compound-corn mix was then mixed with 5 lb of corn to complete the 10-lb inclusion that was added to the complete diet (Table 4).

In this study we used a total of 140 pigs (PIC L327 x 1050) with an initial weight of 54.7 ± 1.8 lb. Pigs were blocked by sex for the 14-d trial. There were 7 pens with 20 pigs per pen.

Statistical Analysis. Data from all experiments were analyzed as a randomized design, with treatment within pen as the experimental unit. Analysis of variance was performed by using the MIXED procedure of SAS. Contrasts were used to determine the effect of

DDGS source and concentration in diets. Linear and quadratic polynomial contrasts were used in Experiment 2 to determine the effects of increasing DDGS concentration.

Results and Discussion

In Experiment 1, there was no significant difference between the control, plant-dried or hand-dried DDGS diets (Table 5) for ADFI from d 0 to 7, but feed intake was numerically less for both plant- and hand-dried DDGS sources. Pigs consumed less (P<0.05) of the diet with wet DDGS. From d 7 to 12 and overall, a difference in ADFI (P<0.01) was observed between the control diet and both drying types. Pigs preferred the control diet; both plant dried and hand dried had intermediate intake. Diets with wet DDGS had the least (P<0.05) feed intake. For the overall study, pigs showed a preference for corn-soybean meal diets over diets containing DDGS, regardless of DDGS, drying method. For the overall group, ADG was 1.68 ± 0.13 kg and F/G was 1.75 ± 0.17.

In Experiment 2, for d 0 to 7, d 7 to 14, and the entire trial, adding DDGS to diets decreased (P<0.05) ADFI compared with corn-soybean meal control diets (Table 6). Within diets containing 30% DDGS, pigs had greater (P<0.05) ADFI for Sources 1 and 6, compared with Source 7. But Source 1 had numerically less ADFI than did Source 6. For this study, the group ADG and F/G was 2.80 ± 0.04 kg and 2.08 ± 0.04, respectively.

In Experiment 3, for the entire trial, the addition of Furfural, γ-Butyrolactone, and Phenyl ethyl alcohol in corn-soybean meal diets had no effect (P>0.92) on feed intake (Table 7). The ADFI was numerically similar between all feeders, and illustrates that no differences in palatability were detected. For this study, the group ADG and G:F was 1.63 ± 0.06 kg and 2.17 ± 0.10 respectively.

New processing techniques and better quality control have lead to a better and more consistent nutrient profile of DDGS. With an improved nutrient profile and more attractive cost, DDGS are being used more frequently in swine diets. But studies evaluating the use of DDGS in swine diets have shown that, as amount of DDGS in the diet increased, there was a decrease in feed intake, independent of nutrient profile. Although many production systems and feed companies use DDGS, they typically limit DDGS inclusion to less then 15% of the diet. Higher concentrations are seldom used because of these reductions in feed intake. Practical diet formulation would allow higher concentrations of DDGS if it did not result in less feed intake. Some producers have shown no negative affects on feed intake with the inclusion of DDGS in swine diets. One commercial study showed no negative affect on intake when DDGS was added at 30% of the diet. But the inclusion of DDGS commonly reduces ADFI in field and research conditions. Feed intake of pigs is critical for pork production because it establishes nutrient intake rates and impacts efficiency of pork production. Feed intake is influenced by a variety of factors, such as stress, health status, genotype, energy density, feed processing, availability of water and flavors.

One of the primary reasons for limited use of DDGS in swine diets traditionally was the poor amino acid digestibilities due to overheating during the drying process. Researchers at the University of Kentucky evaluated nine different DDGS samples; four samples had either a smoky or a burnt odor. Authors did detect differences in feed intake among sources, with those having smoky or burnt odor having the least intake. Over-drying of DDGS may produce burnt or smoky flavors that are undesirable to swine. The variation in color and flavors may be the result of different drying temperatures and times, which can be different between plants. This may be one explanation for the difference in intake seen between DDGS sources. New technology has provided improved ethanol production and drying techniques. Although none of the DDGS sources that we evaluated had smoky or burnt odors or dark color, differences in feed intake were still observed in our studies. Thus, we wanted to evaluate different drying methods and their effects on feed intake of diets with DDGS. Feed intake in Experiment 1 showed that, regardless of drying method, pigs fed diets with DDGS had reduced feed intakes.

Reports from commercial production have shown a variety of responses to feed intake when DDGS is added to diets. We wanted to further evaluate the effects of DDGS source on feed intake. We also wanted to measure the differences in feed intake between diets containing DDGS from corn and milo sources. Therefore, we obtained corn DDGS product from plants that reportedly had little negative effect of feed intake in swine. The corn plants selected were new-generation ethanol facilities in the upper Midwest (Sources 1 and 6). Milo DDGS (Source 7) was obtained from an ethanol production facility in Kansas. As data from Experiment 2 shows, differences in feed intake do exist between sources, even though few differences in color (of corn sources) and nutrient profile existed between the DDGS sources. Thus, whether a DDGS source is considered "good" for feed intake may not be represented in nutrient profile, color, or odor.

No difference in feed intake was detected between any of these compounds tested. Although many different compounds and their interactions contribute to flavor, it is difficult to identify one specific compound or trait in DDGS that decreases feed intake when included in swine diets.

Experiment 3 also indicates that there was no 'position preference' for any feeder, which contradicts work in rats that showed rats, when given a choice of same sources of fluid, showed a regular preference for one container. This problem may have been circumvented by rotation of the feeders twice daily. Providing multiple treatments within a pen allows researchers to evaluate more than one treatment at a given time, and provides indications of responses to treatments to determine if further evaluations are warranted.

These studies illustrate that pigs prefer corn-soybean diets over diets containing DDGS. The decreased palatability seems to increase with increasing amounts of dried distiller grains. Regardless of source, feed intake is decreased when DDGS is included in the diets. Although it seems that the ME content of DDGS is comparable to that of corn, palatability problems may affect pig performance, even when DDGS is included at low concentrations in the diet formulation.

Table 1. Composition of Dried Distillers Grains with Solubles Sources[a]

Item	Source 1	Source 2	Source 3	Source 4	Source 5	Source 6	Source 7
Dry matter, %	92.79	92.99	90.59	90.09	90.59	91.63	92.97
GE, kcal/kg	5,229	5,280	5,162	5,089	5,187	5,105	4,470
Crude protein, %	26.67	30.95	26.7	27.1	26.7	25.5	41.2
Crude fat, %	10.78	9.03	11.1	8.5	11.1	9.3	6.1
Crude fiber, %	5.61	7.62	9.3	9.2	9.3	11.3	9.5
Ash, %	6.16	3.91	3.6	4.4	3.6	4.3	2.6
Ca, %	0.06	0.04	0.08	0.04	0.05	0.07	0.04
P, %	0.73	0.50	0.64	0.67	0.65	0.79	0.27
K, %	0.90	0.51	0.84	0.88	0.89	1.04	0.34
Mg, %	0.31	0.16	0.28	0.29	0.30	0.37	0.13
Zn, ppm	54.1	39.1	47.6	70.8	39.1	61.7	17.4
Fe, ppm	58	46	63	67	65	75	29
Mn, ppm	9	7	8	10	10	14	9
Cu, ppm	5.9	5.1	5.1	4.9	4.6	5.5	2.9
S, %	0.37	0.37	0.30	0.53	0.74	0.51	0.11
Na, %	0.08	0.06	0.08	0.04	0.04	0.07	0.01
NDF, %	26.03	32.61	31.1	29.9	27.8	32.2	32.4
ADF, %	6.85	9.97	17.9	17.3	17.4	14.8	33.5
Amino acids,%							
Arginine	1.15	1.43	--	--	--	--	--
Histidine	0.75	0.98	--	--	--	--	--
Isoleucine	1.03	1.23	--	--	--	--	--
Leucine	3.28	3.97	--	--	--	--	--
Lysine	0.78	1.08	--	--	--	--	--
Met & Cys	1.08	1.42	--	--	--	--	--
Methionine	0.55	0.71	--	--	--	--	--
Phenylalanine	1.36	1.68	--	--	--	--	--
Threonine	1.07	1.25	--	--	--	--	--
Tryptophan	0.19	0.21	--	--	--	--	--
Tyrosine	1.12	1.28	--	--	--	--	--
Valine	1.40	1.66	--	--	--	--	--

[a]Analyzed values for corn DDGS (Sources 1 through 6) and milo DDGS (Source 7) from different sources.

Table 2. Composition of Diets in Experiment 1 (As-fed Basis)

		Dryer Type		
Item, %	Control	Plant Dry	Hand Dried	Wet
Corn	67.48	43.77	42.45	36.67
Soybean meal (46.5% CP)	30.02	24.31	23.58	20.37
DDGS	---	30.00	32.10	41.36
Monocalcium P (21% P)	0.75	---	---	---
Limestone	0.92	1.12	1.08	0.93
Salt	0.35	0.35	0.34	0.29
Vitamin premix[b]	0.15	0.15	0.15	0.13
Trace mineral premix[c]	0.15	0.15	0.15	0.13
Lysine HCl	0.15	0.15	0.15	0.13
DL-methionine	0.03	---	---	---
Total	100.00	100.00	100.00	100.00
Calculated analysis				
Lysine, %	1.20	1.20	1.20	1.20
Methionine, %	28	34	34	34
Threonine, %	63	75	75	75
ME, kcal/lkg	3,331	3,435	3,435	3,435
Protein, %	19.7	23.3	23.3	23.3
Ca, %	0.61	0.58	0.58	0.58
P, %	0.55	0.52	0.52	0.52

Table 3. Composition of Diets in Experiment 2 (As-fed Basis)

		DDGS		
Item, %	Control	Source 1	Source 6	Source 7
Corn	67.51	37.91	37.87	37.63
Soybean meal (46.5% CP)	30.00	30.00	30.00	30.00
DDGS	---	30.00	30.00	30.00
Monocalcium P (21% P)	0.79	0.23	0.33	0.61
Limestone	0.92	1.21	1.15	1.01
Salt	0.35	0.35	0.35	0.35
Vitamin premix	0.15	0.15	0.15	0.15
Trace mineral premix	0.15	0.15	0.15	0.15
Lysine HCl	0.10	---	---	0.10
DL-methionine	0.03	---	---	---
Total	100.00	100.00	100.00	100.00
Calculated analysis				
Lysine, %	1.2	1.24	1.24	1.24
Methionine, %	28	35	35	35
Threonine, %	63	80	80	71
ME, kcal/kg	3,330	3,420	3,419	3,086
Protein, %	19.7	25.5	25.5	29.5
Ca, %	0.62	0.62	0.62	0.62
P, %	0.56	0.56	0.56	0.56

Table 4. Composition of Diets in Experiment 3 (As-fed Basis)

Item, %	Control	Compound: Phenyl Ethyl Alcohol	Compound: Butyrolactone	Compound: Furfural
Corn	67.47	66.96	66.96	66.96
Soybean meal (46.5% CP)	30.02	30.00	30.00	30.00
Monocalcium P (21% P)	0.79	0.79	0.79	0.79
Limestone	0.92	0.92	0.92	0.92
Salt	0.35	0.35	0.35	0.35
Vitamin premix	0.15	0.15	0.15	0.15
Trace mineral premix	0.15	0.15	0.15	0.15
Lysine HCl	0.15	0.15	0.15	0.15
DL-methionine	0.03	0.03	0.03	0.03
Compound + corn	---	0.50	0.50	0.50
Total				
Calculated Analysis				
Lysine, %	1.20	1.20	1.20	1.20
Methionine, %	29	29	29	29
Threonine, %	60	60	60	60
ME, kcal/kg	3,329	3,329	3,329	3,329
Protein, %	19.6	19.6	19.6	19.6
Ca, %	0.62	0.62	0.62	0.62
P, %	0.62	0.62	0.62	0.62

Table 5. Effects of Dried Distiller Grains Drying Method on Feed Intake, Experiment 1[a]

		Dryer Type			
ADFI, lb	Control	Plant Dry	Hand Dried	Wet	SE
d 0 to 7	0.75[b]	0.73[b]	0.69[b]	0.43[c]	0.04
d 7 to 12	0.93[b]	0.67[c]	0.67[c]	0.21[d]	0.03
d 0 to 12	0.84[b]	0.70[c]	0.68[c]	0.32[d]	0.03

[a]A total of 187 pigs (17 pigs per pen and 11 pens) initially 49.4 ± 1.8 lb were given the choice of one of four diets in the same pen; corn-soybean control or control with 30% DDGS replacing corn.
[b,c,d,e]Means within a row with different superscripts differ (*P*<0.05).

Table 6. Effects of DDGS Source on Feed Intake, Experiment 2[a]

		DDGS, 30%			
ADFI, lb	Corn	Source 1	Source 6	Source 7	SE
d 0 to 7	1.16[b]	0.88[c]	1.16[b]	0.57[d]	0.07
d 7 to 14	1.75[b]	0.83[c]	1.42[d]	0.37[e]	0.06
d 14 to 19	2.41[b]	0.73[c]	1.35[d]	0.23[e]	0.05
d 0 to 19	1.71[b]	0.82[c]	1.30[d]	0.41[e]	0.05

[a]A total of 112 pigs (16 pigs per pen and 7 pens) with initial wt of 69.9 ± 1.5 lb were given the choice of one of four diets in the same pen; corn-soybean control with 30% corn DDGS from one of two sources (Sources 1 and 6) or 30% milo DDGS (Source 7).
[b,c,d,e]Means within a row with different superscripts differ (*P*<0.01).

Table 7. Effects of Compounds Found in DDGS on Feed Intake, Experiment 3[a]

		Compound			
ADFI, lb	Control	Phenyl Ethyl Alcohol	Butyrolactone	Furfural	SE
d 0 to 7	0.84	0.84	0.87	0.84	0.03
d 7 to 14	0.94	0.92	0.92	0.93	0.03
d 0 to 14	0.89	0.88	0.90	0.89	0.01

[a]A total of 140 pigs (20 pigs per pen and 7 pens) with initial wt of 54.7 ± 1.8 lb were given the choice of one of four diets in the same pen; corn-soybean control or control plus Phenyl ethyl alcohol, Butyrolactone, or Furfural.

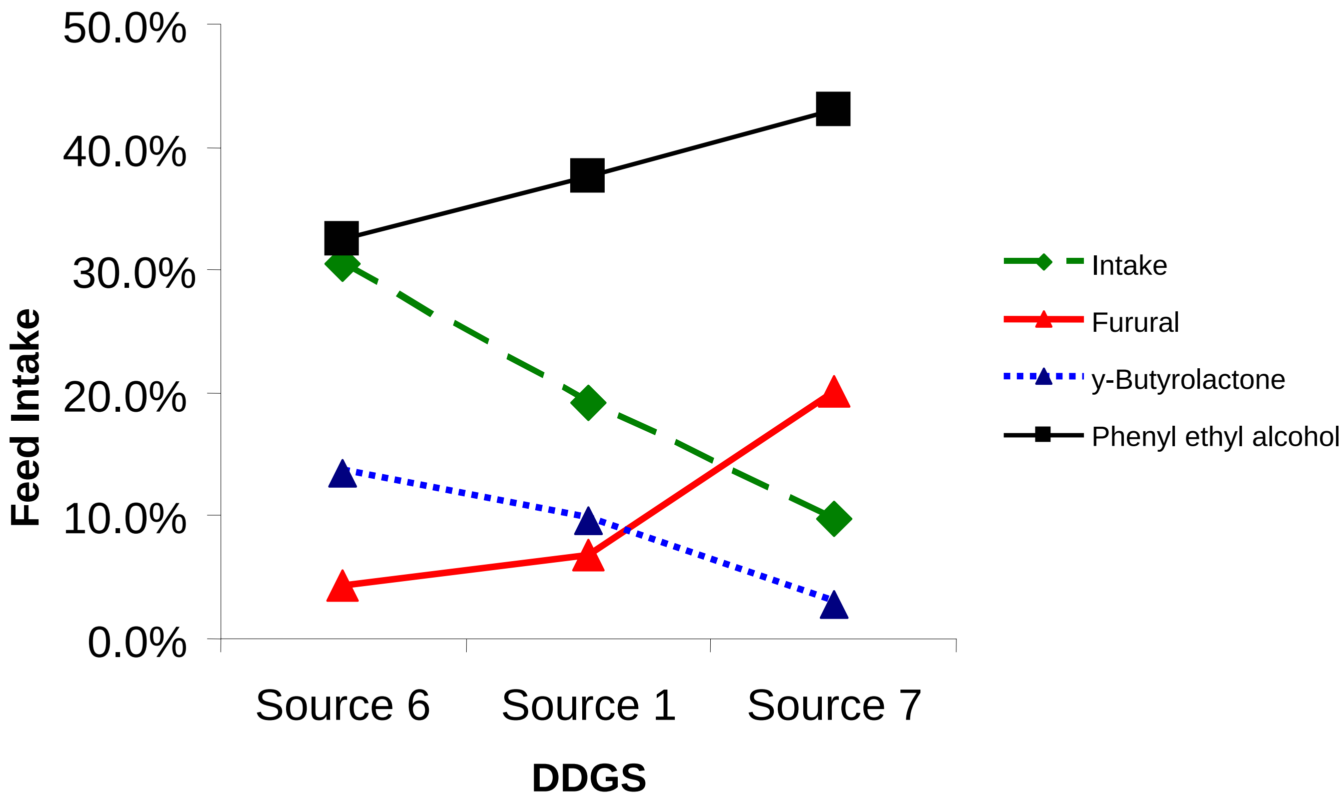

Figure 1. Graph of Feed Intake from Sources 1, 6, and 7 and Concentrations of Specific Compounds Found in each Source.