Final Report: S12402* **October 30, 2012**

Title: Energy Value of Low-oligosaccharide Soybean Meal in Swine.

Introduction and Abstract:

The oligosaccharides in soybean meal (SBM) are anti-nutritional factors that can reduce animal performance. Pigs do not produce the α-galactosidase enzyme, which is needed to cleave the glycosidic bonds in oligosaccharides to be digested. In addition, oligosaccharides increase the viscosity of digesta, thus reducing the digestion of nutrients. Oligosaccharides in SBM are mainly raffinose and stachyose, which represent about 7% of conventional SBM. Therefore, soybean varieties with a low concentration of oligosaccharides may yield more energy available for non-ruminant animals than conventional soybeans. In broilers, Parsons et al. (2010) reported 9.8% more metabolizable energy (ME) in a SBM with low concentration of oligosaccharides (SBM-LO), as compared to a conventional SBM (SBM-C). This project consisted on an energy balance study to measure both digestible energy (DE) and ME for pigs in SBM-C and SBM-LO. Those energy values were measured in grower and finisher pigs.

The conclusions were:

- ✓ The concentration of energy in SBM-LO for grower pigs was 3,986 Kcal of DE and 3,800 Kcal of ME per kg in a dry matter basis.
- ✓ The concentration of energy in SBM-LO for finisher pigs was 4,084 Kcal of DE and 3,747 Kcal of ME per kg in a dry matter basis.
- ✓ The SBM-LO had about 16% more energy in grower pigs, and about 9% more energy in finisher pigs, than the SBM-C.

Objectives:

1. Calculate the DE and ME content in SBM-LO for grower and finisher pigs.
2. Compare the energy value for pigs in SBM-LO versus SBM-C.

Materials and Methods:

The experiment had randomized complete block design with 3 dietary treatments (Table 1). Each treatment had 8 block-replicates; blocks were categories of body weight (BW). The experimental unit was a barrow, housed in an individual metabolic crate. The experiment had 2 phases. Phase 1 used grower pigs with 113±1.3 Lb. of BW. Phase 2 used finisher pigs with 209±0.9 Lb. of BW. Both periods used the same diets and followed the same procedures.

Table 1. Dietary Treatments.

#	Code	Treatment
1.	Corn	Corn diet
2.	SBM-C	SBM-C added at 30% of diet 1, replacing corn
3.	SBM-LO	SBM-LO added at 30% of diet 1, replacing corn

Feed was supplied on a daily basis to provide 2.5 times the ME requirement for maintenance. The ME concentration in corn and SBM-C used to calculate the daily feed offer was that reported by Swine NRC (1998). The ME concentration in SBM-LO used to calculate the daily feed offer was assumed to be 10% larger than that in SBM-C (Appendix Table 1). All diets included a phytase (500 FTU/kg of diet) with neither energy nor phosphorus value. Experimental diets are shown in Appendix Table 2. Both SBM-C and SBM-LO were supplied by the United Soybean Board; these ingredients were manufactured under a study conducted at Virginia Tech in 2010, and supported by the United Soybean Board.

In both phases, pigs were allowed to become adapted to the metabolic crates and experimental diets during a 14-day adaptation period, which was followed by a 4-day total collection period. During the adaptation period, feed offer was adjusted to the minimum feed intake within block. Daily feed budget was divided in 2 meals at 0600 and 1600 h. Orts were also collected twice a day to record actual feed intake. Chromic oxide was used as an indigestible marker in the first meal of collection day 1; fecal collection started as soon as the marker showed up in feces. Ferric oxide was used as an indigestible marker in the first meal after collection day 4; fecal collection stopped as soon as the marker showed up in feces. Urine was collected daily during the 4-day collection period, using HCl to prevent N losses.

The DE in experimental diets was calculated as gross energy intake minus gross energy in feces. The ME in experimental diets was calculated as gross energy intake minus gross energy in feces and urine. Both DE and ME in corn were calculated considering the inclusion of corn in the Corn diet (97.28%) and assuming it was the only source of energy in the diet. The DE and ME in both sources of SBM were calculated by subtracting those energy contributions of corn and considering the SBM inclusion at 30% of the diets. The lab analyses of diets and ingredients are shown in Appendix Tables 3 and 4.

Data from each phase were analyzed independently as a complete randomized block design, using the PROC GLM procedures of SAS. Residual were tested for

normal distribution; no extreme outliers were detected. Pairwise comparisons were used to separate treatment means.

Results and Discussion:

The feed offer was calculated based on the assumption that SBM-LO had 10% more ME than SBM-C. Thus, pigs fed the SBM-LO diet received 3% less feed than those fed the SBM-C diet. However, actual feed intake in phase 1 was 4.5% less in pigs fed SBM-LO diet, as compared to that in pigs fed SBM-C diet. During phase 2, the difference in feed intake between pigs fed either SBM-C or SBM-LO diets was only the 3% less feed offer calculated for pigs fed the SBM-LO diet (Appendix Table 5).

In addition to gross energy intake, the determination of DE and ME in experimental diets included gross energy excretion in fecal matter and urine (Appendix Tables 6 and 7). Then, the percentages of gross energy digestibility and utilization were calculated (Appendix Table 8) to determine the DE and ME contents, respectively, in the diets (Appendix Table 9). Based on that information, the concentrations of DE and ME in the ingredients (corn, SBM-C, and SBM-LO) were determined (Appendix Table 10).

The energy concentration measured in SBM-LO was consistently larger ($P<0.001$) than that in SBM-C (Table 2). In grower pigs, SBM-LO had about 16% more ($P<0.001$) energy than SBM-C; that was a difference of 550 Kcal more of either DE or ME per kg in a dry matter basis. In finisher pigs, SBM-LO had about 9% more ($P<0.001$) energy than SBM-C; that was a difference of 399 Kcal of DE or 292 Kcal of ME per kg in a dry matter basis.

Table 2. Energy concentration measured in SBM-C versus SBM-LO [a,b].

Phase	Item	SBM-C, Kcal/kg	SBM-LO, Kcal/kg	Extra Kcal/kg in SBM-LO
1 (113 Lb. of BW)	Digestible energy			
	as-is	3,206	3,698	+492
	dry matter	3,436	3,986	+550
	Metabolizable energy			
	as-is	3,037	3,529	+492
	dry matter	3,250	3,800	+550
2	Digestible energy			
	as-is	3,426	3,783	+357

≥ (209 Lb. of BW)	dry matter	3,685	4,084	+399
	Metabolizable energy			
	as-is	3,217	3,479	+262
	dry matter	3,454	3,747	+292

[a] SBM-C, conventional soybean meal; SBM-LO, low oligosaccharides soybean meal.

[b] Energy concentration in SBM-C vs. SBM-LO differed, P<0.001.

The larger concentration of extra energy in SBM-LO was detected in grower pigs; a larger energy intake may explain the observed reduction in feed intake of pigs fed the SBM-LO diet in phase 1. In addition, finisher pigs may obtain more energy from dietary fiber through a larger fermentation capacity. The fiber concentration in SBM-LO is lower than that in SBM-C; therefore, it is possible that finisher pigs may obtain more energy from fermentation when SBM-C is fed, and that may explain the smaller concentration of extra energy in SBM-LO during phase 2.

The energy values calculated for corn and SBM-C are in close agreement to those reported by Swine NRC (2012), as shown in Table 3. These observations provide confidence on the energy values measured for both SBM sources.

Table 3. Energy concentration (Kcal/kg) in corn and SBM-C [a] (dry matter basis).

		Corn			SBM-C		
Phase	Energy	NRC	Measured	≠, %	NRC	Measured	≠, %
1	DE	3,908	3,889	-0.5	4,022	3,436	-17.0
2			3,849	-1.5		3,685	-9.1
1	ME	3,844	3,799	-1.2	3,661	3,250	-12.6
2			3,739	-2.8		3,454	-6.0

[a] SBM-C, conventional soybean meal.

Conclusions:

The concentration of energy in SBM-LO for grower pigs was 3,986 Kcal of DE and 3,800 Kcal of ME per kg in a dry matter basis.

The concentration of energy in SBM-LO for finisher pigs was 4,084 Kcal of DE and 3,747 Kcal of ME per kg in a dry matter basis.

The SBM-LO had about 16% more energy in grower pigs, and about 9% more energy in finisher pigs, than the SBM-C.

Appendix Table 1. Partial chemical composition of soybean meal conventional and low oligosaccharides.

		SBM, NSNG 47.5% CP (970433)				SBM, USB lab 52% CP DM (970434)			
		Total		SID		Total		SID	
Code	Item	as-is, %	DM, %	as-is, %	DM, %	as-is, %	DM, %	as-is, %	DM, %
2	DM, %	90.00	100.00			93.20	100.00		
	Hum., %	10.00	0.00			**6.80**	0.00		
4	CP,%	**47.50**	52.78			48.46	**52.00**		
365	Ala					2.03	2.18		
366	Arg	3.48	3.87	3.27	3.63	3.47	3.72	3.26	3.4968
367	Asp					5.34	5.73		
368	Cys	0.74	0.82	0.64	0.72	0.77	0.83	0.67	0.7221
369	Glu					8.45	9.07		
370	Gly					2.02	2.17		
371	His	1.28	1.42	1.16	1.29	1.29	1.38	1.17	1.2558
372	Ile	2.16	2.40	1.92	2.14	2.26	2.42	2.01	2.1538
373	Leu	3.66	4.07	3.26	3.62	3.73	4.00	3.32	3.5600
374	Lys	3.02	3.36	2.72	3.02	3.08	3.30	2.77	2.9700
377	Met	0.67	0.74	0.61	0.68	0.65	0.70	0.59	0.6370
379	Phe	2.39	2.66	2.13	2.36	2.43	2.61	2.16	2.3229
380	Pro					2.62	2.81		
381	Ser					2.04	2.19		
383	Thr	1.85	2.06	1.61	1.79	1.84	1.97	1.60	1.7139
384	Trp	0.65	0.72	0.59	0.65	0.65	0.70	0.59	0.6300
385	Tyr	1.82	2.02	1.64	1.82	1.76	1.89	1.59	1.7010
386	Val	2.27	2.52	2.00	2.22	2.39	2.56	2.10	2.2528
378	TSAA	1.41	1.57	1.25	1.39	1.43	1.53	1.27	1.3591
525	Ile/Lys		0.72		0.71		0.7333		0.7252
526	Met/Lys		0.22		0.22		0.2121		0.2145
527	TSAA/Lys		0.47		0.46		0.4636		0.4576
528	Thr/Lys		0.61		0.59		0.5970		0.5771
529	Trp/Lys		0.22		0.22		0.2121		0.2121
530	Val/Lys		0.75		0.73		0.7758		0.7585
ME, kcal/Lb		1,536.00				1,689.60			

Appendix Table 2. Experimental diets.

Treatment number:	1	2	3
Diet number:	HGM2611	HGM2612	HGM2613
Ingredients, %			
CORN GRD	97.28	67.28	67.28
CALCIUM CARBONATE 38	2.00	2.00	2.00
SALT	0.50	0.50	0.50
SWINE TM MIX	0.10	0.10	0.10
SEL .06%	0.05	0.05	0.05
HOG G/F VM	0.05	0.05	0.05
PHYZYME XP 2500G	0.02	0.02	0.02
SBM		30.00	
SBM-LO			30.00
Total Batch	100.00	100.00	100.00
Nutrients, %			
DRY MATTER	87.30	89.15	88.91
MOISTURE	12.70	10.85	11.09
PROTEIN	6.33	18.92	19.49
FAT; CRUDE	3.13	2.50	2.42
CRUDE FIBER	1.23	1.89	1.89
STARCH	60.87	42.81	42.81
ACID DET FIBER	3.32	3.86	3.86
NEUT DET FIBER	7.31	7.37	7.37
ME SWINE (kcal/Lb)	1512.70	1507.00	1553.08
ASH	3.93	5.25	5.25
CALCIUM	0.83	0.98	0.98
PHOSPHORUS	0.24	0.37	0.37
PHOS AVAIL-SWINE	0.04	0.09	0.09
LYSINE	0.21	1.07	1.11
AVAIL LYS SWINE	0.18	0.95	0.99
AMET/LYS S	0.69	0.28	0.27
ASAA/LYS S	1.48	0.59	0.58
ATHR/LYS S	0.94	0.62	0.61
ATRP/LYS S	0.22	0.21	0.21

ADM Animal Nutrition Research - S12402

Appendix Table 3. Lab analyses of diets and ingredients.

Phase	Analysis	Units, as-is	Diets			Ingredients		
			HGM2611 (CORN)	HGM2612 (SBM-C)	HGM2613 (SBM-LO)	CORN	SBM-C	SBM-LO
1	MOISTURE	%	12.43	10.81	10.80	12.66	6.87	7.18
	PROTEIN	%	7.90	18.60	19.90	7.50	47.80	49.80
	ADF	%	3.20	4.20	3.80	3.20	9.50	5.50
	aNDF	%	7.50	8.00	7.00	7.40	10.40	7.20
	GROSS ENERGY (GE)	CAL/GRAM	3,846	3,805	3,937	3,849	4,250	4,306
	FAT, PET ETHER	%	3.20	2.50	2.20	3.30	0.80	0.60
	ASH	%	3.90	5.00	5.00	1.50	6.10	6.20
	CRUDE FIBER	%	2.40	3.20	2.80	3.10	6.00	3.80
	STARCH	%	66.10	49.90	49.90	71.50	5.50	6.20
	CALCIUM	%	0.87	0.89	0.87	0.10	0.32	0.23
	PHOSPHORUS	%	0.25	0.37	0.39	0.28	0.59	0.75
2	MOISTURE	%	12.72	10.70	10.53	12.66	6.87	7.18
	PROTEIN	%	8.00	20.50	21.00	7.80	47.30	49.80
	ADF	%	3.30	4.40	4.50	3.00	7.70	5.60
	aNDF	%	8.80	8.90	8.10	8.10	10.90	8.90
	GROSS ENERGY (GE)	CAL/GRAM	3,846	3,805	3,937	3,849	4,250	4,306
	FAT	%	3.10	2.40	2.30	3.10	1.00	0.70
	ASH	%	3.40	5.00	5.00	1.70	6.00	6.20
	CRUDE FIBER	%	1.90	3.00	2.40	1.80	5.20	3.50
	STARCH	%	67.20	48.50	48.90	70.50	5.60	6.20
	CALCIUM	%	0.79	0.87	0.92	0.17	0.30	0.26
	PHOSPHORUS	%	0.24	0.32	0.40	0.22	0.55	0.66

ADM Animal Nutrition Research - S12402

Appendix Table 4. Sugars profile of diets.

Phase	Analysis	Units, as-is	Experimental diets		
			HGM2611 (CORN)	HGM2612 (SBM)	HGM2613 (SBM-LO)
1	GLUCOSE	%	0.44	0.28	0.23
	SUCROSE	%	1.98	3.40	5.64
	MALTOSE	%	0	0	0
	FRUCTOSE	%	0.38	0.26	0.24
	STACHYOSE	%	0	1.62	0
	RAFFINOSE	%	0.17	0.47	0.18
2	GLUCOSE	%	0.24	0.27	0.35
	SUCROSE	%	6.13	3.93	2.01
	MALTOSE	%	0	0	0
	FRUCTOSE	%	0.25	0.24	0.31
	STACHYOSE	%	0.16	2.06	0
	RAFFINOSE	%	0.30	0.46	0.16

ADM Animal Nutrition Research - S12402

Appendix Table 5. Feed intake and body weights.

Phase	Response	Diet LSMean Corn	SBM-C	SBM-LO	SEM	p-values Overall Trt	Corn vs SBM-C	Corn vs SBM-LO	SBM-C vs SBM-LO
1	**Feed intake, lb/d**								
	Pretest period	3.234	3.245	3.149	0.001	<0.001	<0.001	<0.001	<0.001
	Test period	3.268	3.321	3.172	0.024	0.002	0.144	0.013	0.001
	Body weight, lb								
	Adaptation end	109.1	115.6	113.7	1.3	0.011	0.004	0.030	0.318
	Test end	113.2	124.5	124.0	1.0	<0.001	<0.001	<0.001	0.698
	Weight gain, lb/hd/d	1.031	2.219	2.575	0.127	<0.001	<0.001	<0.001	0.068
2	**Feed intake, lb/d**								
	Pretest period	5.088	5.108	4.931	0.041	0.016	0.735	0.017	0.009
	Test period	5.162	5.176	5.019	0.012	<0.001	0.396	<0.001	<0.001
	Body weight, lb								
	Adaptation end	202.3	214.3	211.7	0.9	<0.001	<0.001	<0.001	0.055
	Test end	211.5	229.0	225.4	1.1	<0.001	<0.001	<0.001	0.040
	Weight gain, lb/hd/d	2.294	3.681	3.425	0.310	0.016	0.007	0.022	0.568

ADM Animal Nutrition Research - S12402

Appendix Table 6. Fecal and urine weights.

Phase	Response	Diet LSMean Corn	SBM	SBM-LO	SEM	p-values Overall Trt	Corn vs SBM-C	Corn vs SBM-LO	SBM-C vs SBM-LO
1	**Fecal weight, g/4d**								
	As-is	1,926.8	2,220.5	2,151.1	119	0.226	0.103	0.205	0.687
	Dry	651.5	696.0	645.7	22.9	0.269	0.191	0.862	0.143
	Fecal dry matter, %	34.0	31.7	30.4	0.96	0.051	0.105	0.018	0.353
	Urine weight, g/4d	8,384.6	20,142.7	26,930.2	5470	0.086	0.151	0.031	0.395
2	**Fecal weight, g/4d**								
	As-is	3,011.6	2,990.9	2,909.4	88	0.695	0.871	0.427	0.525
	Dry	1,070.6	1,012.2	1,030.5	23	0.221	0.095	0.238	0.584
	Fecal dry matter, %	35.7	34.1	35.4	0.92	0.438	0.240	0.857	0.314
	Urine weight, g/4d	12,026.4	22,631.3	17,381.5	3213	0.100	0.035	0.258	0.267

ADM Animal Nutrition Research - S12402

Appendix Table 7. Energy and nutrients excretion.

Phase	Response	Diet LSMean Corn	SBM	SBM-LO	SEM	p-values Overall Trt	Corn vs SBM-C	Corn vs SBM-LO	SBM-C vs SBM-LO
	Fecal excretion, g (except GE)								
	DRY MATTER	651.46	696.03	645.71	22.9	0.269	0.191	0.862	0.143
	NITROGEN	16.23	25.41	22.91	1.52	0.003	0.001	0.009	0.252
	ADF	75.94	104.46	72.08	4.56	<0.001	0.001	0.558	<0.001
	NDF	263.63	259.44	212.23	12.9	0.024	0.821	0.014	0.021
	CRUDE FIBER	62.79	89.74	66.80	3.66	<0.001	<0.001	0.451	0.001
	ASH	94.30	101.68	97.33	5.20	0.612	0.333	0.686	0.564
	CALCIUM	27.69	26.41	28.42	1.90	0.755	0.642	0.789	0.467
1	PHOSPHORUS	10.45	12.40	12.86	0.70	0.066	0.070	0.029	0.652
	GROSS ENERGY (GE), kcal	3,161	3,318	3,083	106	0.312	0.314	0.612	0.140
	Urine excretion, g (except GE)								
	DRY MATTER	214.41	376.22	345.17	8.8	<0.001	<0.001	<0.001	0.025
	NITROGEN	27.71	74.69	72.94	3.66	<0.001	<0.001	<0.001	0.732
	ASH	65.61	124.11	104.89	4.09	<0.001	<0.001	<0.001	0.005
	CALCIUM	6.72	10.64	5.14	0.578	<0.001	<0.001	0.073	<0.001
	PHOSPHORUS	0.10	0.15	0.23	0.026	0.011	0.207	0.003	0.044
	GROSS ENERGY (GE), kcal	455.54	631.34	602.86	83.0	0.305	0.156	0.230	0.812
	Fecal excretion, g (except GE)								
	DRY MATTER	1,070.63	1,012.21	1,030.45	23	0.221	0.095	0.238	0.584
	NITROGEN	26.60	34.35	33.38	1.48	0.004	0.002	0.006	0.651
	ADF	123.79	142.74	125.62	9.2	0.308	0.169	0.890	0.211
	NDF	444.04	336.29	338.72	13.9	<0.001	<0.001	<0.001	0.903
	CRUDE FIBER	120.14	110.43	114.51	5.9	0.520	0.263	0.510	0.631
	ASH	187.85	200.04	212.99	7.3	0.086	0.259	0.029	0.232
	CALCIUM	64.36	61.76	64.07	3.08	0.810	0.560	0.948	0.604
2	PHOSPHORUS	19.77	22.07	24.01	0.70	0.003	0.035	0.001	0.069
	GROSS ENERGY (GE), kcal	5,319	4,783	4,870	123	0.018	0.008	0.022	0.626
	Urine excretion, g (except GE)								
	DRY MATTER	330.00	551.93	499.96	17.9	<0.001	<0.001	<0.001	0.059
	NITROGEN	44.98	132.11	129.08	4.30	<0.001	<0.001	<0.001	0.626
	ASH	101.39	205.33	171.86	6.3	<0.001	<0.001	<0.001	0.002
	CALCIUM	6.44	10.66	3.43	0.907	<0.001	0.005	0.034	<0.001
	PHOSPHORUS	0.14	0.15	0.20	0.030	0.271	0.814	0.138	0.204
	GROSS ENERGY (GE), kcal	875.06	1,200.93	1,426.35	141.8	0.047	0.127	0.016	0.280

ADM Animal Nutrition Research - S12402

Appendix Table 8. Digestibility and utilization of energy and nutrients in the diets.

Phase	Response	Diet LSMean Corn	SBM	SBM-LO	SEM	p-values Overall Trt	Corn vs SBM-C	Corn vs SBM-LO	SBM-C vs SBM-LO
	Nutrient digestibility, %								
	DRY MATTER	87.46	87.02	87.40	0.45	0.757	0.498	0.925	0.558
	NITROGEN	78.14	85.77	87.47	0.93	<0.001	<0.001	<0.001	0.206
	ADF	60.11	58.65	67.04	2.28	0.046	0.659	0.049	0.021
	NDF	40.88	46.06	47.24	2.93	0.295	0.232	0.147	0.779
	CRUDE FIBER	55.95	53.42	58.53	2.24	0.304	0.438	0.429	0.129
	ASH	59.22	66.16	66.05	1.85	0.029	0.019	0.021	0.966
	CALCIUM	46.34	50.57	42.93	3.87	0.400	0.452	0.544	0.184
1	PHOSPHORUS	29.58	44.22	42.48	3.54	0.022	0.011	0.022	0.732
	GROSS ENERGY (GE)	86.14	85.50	86.38	0.48	0.421	0.353	0.732	0.211
	Nutrient utilization, %								
	DRY MATTER	83.34	80.01	80.68	0.55	0.002	0.001	0.004	0.402
	NITROGEN	42.45	44.04	47.60	2.46	0.347	0.661	0.169	0.308
	ASH	30.92	25.00	29.65	2.53	0.254	0.120	0.728	0.215
	CALCIUM	33.32	30.67	32.66	4.01	0.889	0.647	0.908	0.731
	PHOSPHORUS	28.89	43.54	41.43	3.59	0.025	0.012	0.027	0.683
	GROSS ENERGY (GE)	84.14	82.76	83.73	0.64	0.321	0.149	0.661	0.299
	Nutrient digestibility, %								
	DRY MATTER	86.91	87.92	87.36	0.28	0.069	0.023	0.281	0.177
	NITROGEN	77.85	88.84	89.11	0.58	<0.001	<0.001	<0.001	0.745
	ADF	59.89	65.36	69.34	2.46	0.051	0.138	0.017	0.272
	NDF	46.10	59.74	53.99	1.84	<0.001	<0.001	0.009	0.044
	CRUDE FIBER	32.61	60.74	47.54	2.73	<0.001	<0.001	0.002	0.004
	ASH	41.02	57.44	53.18	1.71	<0.001	<0.001	<0.001	0.100
	CALCIUM	13.08	24.57	27.29	3.10	0.014	0.018	0.007	0.554
2	PHOSPHORUS	12.17	26.58	34.05	2.28	<0.001	0.001	<0.001	0.036
	GROSS ENERGY (GE)	85.25	86.61	86.43	0.34	0.027	0.013	0.028	0.709
	Nutrient utilization, %								
	DRY MATTER	82.87	81.34	81.22	0.39	0.017	0.015	0.010	0.832
	NITROGEN	40.32	45.94	46.81	2.00	0.076	0.067	0.037	0.761
	ASH	12.86	13.69	16.83	2.14	0.431	0.791	0.244	0.297
	CALCIUM	7.36	12.77	23.73	3.58	0.028	0.351	0.016	0.034
	PHOSPHORUS	11.57	26.10	33.50	2.25	<0.001	<0.001	<0.001	0.036
	GROSS ENERGY (GE)	82.81	83.25	82.45	0.55	0.599	0.577	0.654	0.321

ADM Animal Nutrition Research - S12402

Appendix Table 9. Digestible and metabolizable energy in diets.

Phase	Response	Diet LSMean Corn	SBM	SBM-LO	SEM	p-values Overall Trt	Corn vs SBM-C	Corn vs SBM-LO	SBM-C vs SBM-LO
1	**Digestible energy, kcal/kg**								
	As-is moisture basis	3,313	3,253	3,401	18	<0.001	0.037	0.005	<0.001
	Dry matter basis	3,783	3,648	3,813	21	<0.001	<0.001	0.337	<0.001
	Metabolizable energy, kcal/kg								
	As-is moisture basis	3,236	3,149	3,297	25	0.003	0.026	0.103	0.001
	Dry matter basis	3,695	3,531	3,696	28	0.001	0.001	0.991	0.001
2	**Digestible energy, kcal/kg**								
	As-is moisture basis	3,279	3,295	3,403	13	<0.001	0.383	<0.001	<0.001
	Dry matter basis	3,744	3,695	3,815	15	<0.001	0.034	0.005	<0.001
	Metabolizable energy, kcal/kg								
	As-is moisture basis	3,185	3,168	3,246	21	0.049	0.577	0.061	0.020
	Dry matter basis	3,637	3,552	3,639	24	0.034	0.025	0.945	0.021

ADM Animal Nutrition Research - S12402

Appendix Table 10. Digestible and metabolizable energy in ingredients.

Phase	Response	Ingredient LSMean Corn	SBM	SBM-LO	SEM	p-values Overall Trt	Corn vs SBM-C	Corn vs SBM-LO	SBM-C vs SBM-LO
1	**Digestible energy, kcal/kg**								
	As-is moisture basis	3,406	3,206	3,698	11	<0.001	<0.001	<0.001	<0.001
	Dry matter basis	3,889	3,436	3,986	12	<0.001	<0.001	<0.001	<0.001
	Metabolizable energy, kcal/kg								
	As-is moisture basis	3,326	3,037	3,529	15	<0.001	<0.001	<0.001	<0.001
	Dry matter basis	3,799	3,250	3,800	17	<0.001	<0.001	0.949	<0.001
2	**Digestible energy, kcal/kg**								
	As-is moisture basis	3,370	3,426	3,783	8	<0.001	<0.001	<0.001	<0.001
	Dry matter basis	3,849	3,685	4,084	9	<0.001	<0.001	<0.001	<0.001
	Metabolizable energy, kcal/kg								
	As-is moisture basis	3,274	3,217	3,479	12	<0.001	0.005	<0.001	<0.001
	Dry matter basis	3,739	3,454	3,747	14	<0.001	<0.001	0.690	<0.001

ADM Animal Nutrition Research - S12402

*Financial support for this study provided by the United Soybean Board