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Gestating sows have greater digestibility of energy in full fat rice bran and defatted rice bran than growing gilts regardless of level of feed intake

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ABSTRACT: The first objective of this experiment was to test the hypothesis that apparent total tract digestibility (ATTD) of GE and nutrients in full fat rice bran (FFRB) and defatted rice bran (DFRB) determined in gestating sows is greater if feed is provided at 1.5 × the ME required for maintenance than at 3.5 × the ME requirement. The second objective was to test the hypothesis that the ATTD of GE and nutrients and the concentrations of DE and ME in FFRB and DFRB is not different between growing gilts and gestating sows if both groups of animals are fed 3.5 × the maintenance requirement for ME. Forty eight gestating sows (parity 2 to 6) were allotted to 3 diets and 2 levels of feed intake (i.e., 1.5 or 3.5 × the maintenance requirement for ME) in a randomized complete block design, with 4 blocks of 12 sows and 2 replicate sows per block for a total of 8 replicate sows per diet. Twenty four growing gilts (51.53 ± 3.1 kg BW) were randomly allotted to the same 3 diets, but all gilts were fed at 3.5 × the maintenance requirement for ME. A basal diet containing corn and soybean meal and 2 diets that consisted of 60% basal diet and 40% FFRB or DFRB were used. Results of the experiment indicated that there were no effects of level of feed intake of sows on ATTD of GE, DM, OM, or NDF, or on concentrations of DE and ME. However, concentrations of DE and ME were greater ($P < 0.05$) in FFRB than in DFRB regardless of feed intake level. The ATTD of GE, OM, DM, and NDF of diets containing FFRB or DFRB was less ($P < 0.05$) than in the basal diet, regardless of the physiological stage of the animals. However, the ATTD of GE, OM, and NDF of the basal diet and diets containing FFRB or DRFB was greater ($P < 0.05$) in gestating sows than in growing gilts. Concentrations of DE and ME in the diets were also greater ($P < 0.05$) if determined in gestating sows than in growing gilts. The ATTD of GE and the concentrations of DE and ME of FFRB were greater ($P < 0.05$) than in DFRB and these values were also greater ($P < 0.05$) in gestating sows than in growing gilts. In conclusion, the level of feed intake by gestating sows did not affect the digestibility of GE and nutrients or the concentrations of DE and ME in diets or in FFRB or DFRB, but the ATTD of GE and the concentration of DE and ME in diets and in FFRB and DFRB were greater in gestating sows than in growing gilts.

Key words: digestibility, energy, feed intake, gestating sows, growing pigs, rice bran

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INTRODUCTION

The apparent total tract digestibility (**ATTD**) of energy by pigs may be affected by the physiological stage of the animals and the feeding level (Noblet and Shi, 1993; Chastanet et al., 2007). Differences in digestibility of energy between growing pigs and sows have been demonstrated and explained by the greater capacity for degradation of fiber in sows compared with growing pigs (Shi and Noblet, 1993; Le Goff and Noblet, 2001). However, gestating sows are usually restricted in their feed allowance, which may affect rate of passage through the intestinal tract and the efficiency of digestion. It is, therefore, not known if the greater digestibility of energy by gestating sows is due to only physiological differences between sows and growing pigs or if the fact that gestating sows are fed less than growing pigs contributes to the differences that have

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been reported (Fernández et al., 1986; Shi and Noblet, 1993; Le Goff and Noblet, 2001). There is, therefore, a need to separate the effect of physiological stage and the effect of the level of feed intake on ATTD of energy and nutrients by gestating sows and growing pigs.

The ATTD of GE is between 72.8 and 80.0% in full fat rice bran (**FFRB**) and defatted rice bran (**DFRB**) fed to growing pigs (Robles and Ewan, 1982; Kaufmann et al., 2005; Casas and Stein, 2016). However, no values for the ATTD of GE or for DE and ME of FFRB and DFRB fed to gestating sows have been reported. Therefore, the first objective of this experiment was to test the hypothesis that the ATTD of GE, DM, OM, and NDF in FFRB and DFRB determined in gestating sows is greater at a feed intake level of 1.5 × ME required for maintenance than at 3.5 × the ME requirement. The second objective was test the hypothesis that the ATTD of GE and nutrients and the concentrations of DE and ME in FFRB and DFRB is not different between growing gilts or gestating sows if both groups of animals are allowed to consume feed at a level that is close to ad libitum intake.

MATERIALS AND METHODS

The protocol for this experiment was reviewed and approved by the Institutional Animal Care and Use Committee at the University of Illinois.

Animals, Housing, Diets, and Sample Collection

Forty eight gestating sows (35 ± 0.8 d of pregnancy; parity 2 to 6), were allotted to a randomized complete block design with 3 diets and 2 levels of feed intake (1.5 or 3.5 × the maintenance ME requirement) for a total of 6 dietary treatments. There were 4 blocks of 12 sows, 2 replicate sows per block, and 8 replicate sows per treatment. Twenty four growing gilts (51.53 ± 3.1 kg BW) were randomly allotted to the same 3 diets, and they were provided feed at 3.5 × the maintenance ME requirement. Sows were Fertilis 25 (Genetiporc, Alexandria, MN) and gilts were the offspring of Fertilis 25 females mated to G-Performer males (Genetiporc, Alexandria, MN). The ME requirement for sows was estimated at 100 kcal ME per kg $BW^{0.75}$ (NRC, 2012), and the ME requirement for growing gilts was estimated at 197 kcal ME per kg $BW^{0.60}$ (NRC, 2012).

A basal diet containing corn and soybean meal and 2 diets based on corn, soybean meal, and FFRB or DFRB were used (Table 1). Full fat rice bran and DFRB were included at 40% of the diets (Table 2). All diets were formulated to contained 500 units per kg of microbial phytase [Quantum Blue, (5000 phytase units per gram) AB Vista, Marlborough, UK], and vitamins and minerals in concentrations that exceeded the requirement for growing pigs and gestating sows (NRC, 2012). The same batch of the 3 diets was fed to all animals throughout the experiment. Gilts and sows were fed equal amounts of feed daily at 0700 and 1600 h and all animals had free access to water throughout the experiment.

Table 1. Analyzed nutrient composition of corn, soybean meal, full fat rice bran (FFRB) and defatted rice bran (DFRB)

	Ingredient			
Item	Corn	Soybean meal	FFRB	DFRB
GE, kcal/kg	3,835	4,183	5,116	3,874
DM, %	87.20	90.25	97.90	90.60
CP,%	7.16	47.11	16.25	16.34
AEE[1], %	3.42	0.28	16.70	3.97
Ash, %	1.56	5.89	9.20	12.10
Starch,%	62.42	0.15	12.90	19.8
ADF,%	2.37	3.96	9.73	8.81
NDF,%	8.00	8.47	18.28	17.78
Lignin, %	1.39	1.03	9.35	5.03
Ca, %	0.01	0.30	0.05	1.07
P, %	0.26	0.64	2.00	2.24

[1]AEE = acid hydrolyzed ether extract.

Growing gilts and gestating sows were fed experimental diets for 24 d. For the initial 12 d, sows and gilts were housed in individual pens, but on d 13, they were moved to metabolism crates. Metabolism crates were equipped with a feeder and a nipple drinker, a fully slatted floor, a screen floor, and a urine pan.

Five d after gilts and sows were moved to the metabolism crates (d 18 of the experiment), a color marker was included in the morning meal (chromic oxide) and a second marker (ferric oxide) was included in the morning meal on d 23. Fecal collection was initiated when chromic oxide appeared in the feces and ceased when ferric oxide appeared (Adeola, 2001). Feces were collected twice daily and stored at –20°C as soon as collected. Urine collections started on d 18 at 1700 h and ceased on d 23 at 1700 h. Urine was collected in buckets placed under the metabolism crates over a preservative of 50 mL of 3*N* HCl. Buckets were emptied daily, the weight of the collected urine was recorded, and 10% of the collected urine was stored a –20°C. At the conclusion of the experiment, urine samples were thawed and mixed within animal and subsamples were collected for analysis.

Chemical Analyses

Fecal samples were dried at 65°C in a forced air oven and ground through a 1-mm screen before analysis. Urine samples were lyophilized before analysis (Kim et al., 2009). Samples of energy-containing ingredients, diets, feces, and urine were analyzed for GE us-

Table 2. Composition of basal diet and diets containing full fat rice bran (FFRB) or defatted rice bran (DFRB)

	Diets		
Item	Basal	FFRB	DFRB
Ingredient, %			
Corn	63.60	37.11	37.11
Soybean meal	32.27	19.05	19.05
Rice co-products	–	40.00	40.00
Limestone	0.78	1.64	1.64
Dicalcium phosphate	1.15	–	–
Sodium chloride	0.40	0.40	0.40
Vitamin mineral premix[1]	0.30	0.30	0.30
Phytase premix[2]	1.00	1.00	1.00
Titanium dioxide	0.50	0.50	0.50
Total	100.00	100.00	100.00
Analyzed composition			
GE, kcal/kg	3,819	4,260	3,809
DM, %	88.03	92.63	88.95
CP,%	20.26	17.58	18.96
AEE[3], %	2.15	8.32	3.50
Ash, %	5.30	6.90	8.80
ADF,%	4.78	5.74	6.75
NDF,%	9.07	11.48	12.17
Lignin,%	0.73	1.42	2.63
Ca, %	0.65	0.66	1.16
P, %	0.6	0.98	1.09
Phytase, phytase units/kg	690	690	430

[1]The vitamin-micromineral premix provided the following quantities of vitamins and micro minerals per kilogram of complete diet: vitamin A as retinyl acetate, 11,136 IU; vitamin D_3 as cholecalciferol, 2,208 IU; vitamin E as DL-alpha tocopheryl acetate, 66 IU; vitamin K as menadione dimethylprimidinol bisulfite, 1.42 mg; thiamin as thiamine mononitrate, 0.24 mg; riboflavin, 6.59 mg; pyridoxine as pyridoxine hydrochloride, 24 mg; vitamin B_{12}, 0.03 mg; D-pantothenic acid as D-calcium pantothenate, 23.5 mg; niacin, 44.1 mg; folic acid, 1.59 mg; biotin, 0.44 mg; Cu, 20 mg as copper sulfate and copper chloride; Fe, 126 mg as ferrous sulfate; I, 1.26 mg as ethylenediamine dihydriodide; Mn, 60.2 mg as manganese sulfate; Se, 0.3 mg as sodium selenite and selenium yeast; and Zn, 125.1 mg as zinc sulfate.

[2]The phytase premix was formulated to provide 500 units of phytase per kilogram of complete feed in all diets. The premix was prepared by mixing 10 g of phytase [Quantum Blue (5,000 units per gram) AB Vista, Marlborough, UK] with 990 g of ground corn. The premix thus contained 50,000 units of phytase per kilogram, and at 1% inclusion provided 500 units of phytase per kilogram of complete diet.

[3]AEE = acid hydrolyzed ether extract.

ing an isoperibol bomb calorimeter (Model 6300, Parr Instruments, Moline, IL). Benzoic acid was used as the standard for calibration. Samples of ingredients, diets, and feces were analyzed for DM (Method 930.15; AOAC International, 2007) and ash (Method 942.05; AOAC International, 2007). These samples were also analyzed for NDF using Ankom Technology method 13 (Ankom 2000 Fiber Analyzer, Ankom Technology, Macedon, NY). Ingredients and diets were also analyzed for ADF and lignin using Ankom Technology methods 12 and 9, respectively (Ankom 2000 Fiber Analyzer, Ankom Technology, and the Daisy*II* Incubator, Ankom Technology, Macedon, NY). Crude protein was analyzed in ingredients and diets by combustion (Method 990.03; AOAC International, 2007) using an Elementar Rapid N-cube Protein/Nitrogen Apparatus (Elementar Americas Inc., Mt Laurel, NJ), and acid hydrolyzed ether extract (**AEE**) was analyzed by acid hydrolysis using 3*N* HCl (Sanderson, 1986) followed by crude fat extraction using petroleum ether (Method 2003.6; AOAC International, 2007) on an automated analyzer (Soxtec 2050; FOSS North America, Eden Prairie, MN). Ingredients and diets were also analyzed for Ca and P (Method 975.03; AOAC International, 2007) and all ingredients were analyzed for starch (Method 979.10; AOAC International, 2007). Phytase activity (method 2000.012; AOAC International, 2007) was also analyzed in all diets.

Calculations and Statistical Analysis

Organic matter was calculated as the difference between DM and ash. The DE and ME and the ATTD of GE, DM, and NDF in diets were calculated using the direct method (Adeola, 2001). The contribution of the basal diet to the diets containing rice co-products was subtracted from the values for these diets and the DE, ME, and ATTD of GE, DM, OM, and NDF in FFRB and DFRB were calculated by difference (Adeola, 2001). Outliers and homogeneity of the variances among treatments were tested using the UNIVARIATE procedure of SAS (SAS Inst. Inc., Cary, NC). Data were analyzed using the MIXED procedure of SAS. To test the effect of feeding level in gestating sows or the effects of the physiological stage, data were analyzed as a randomized complete block design in a 2 × 3 factorial arrangement for diets and 2 × 2 factorial arrangement for ingredients. The fixed effects were the diet or ingredient and the feeding level or physiological stage, and the interaction between diet or ingredient and feeding levels or physiological stage. Block and replicate were considered random effects. The LSMeans statement was used to calculate treatment means and the PDIFF option was used to separate means if differences were detected. The pig was the experimental unit for all analyses and statistical significance and tendency were considered at $P < 0.05$ and $0.05 \leq P < 0.10$, respectively.

RESULTS

The basal diet and diets containing FFRB or DFRB contained 3,819, 4,260, and 3,809 kcal/kg of GE, respectively and concentrations of CP were 20.6, 17.5, and 18.9%, respectively (Table 2). Values for ADF and NDF were 4.78 and 9.07% for the basal diet, 5.74 and 11.48 for the FFRB diet, and 6.75 and 12.17% for the DFRB diet. All analyzed values were close to formulated values.

Table 3. Effect of feed intake level on apparent total tract digestibility (ATTD) of GE, DM, OM, and NDF and concentration of DE and ME of the basal diet and diets containing full fat rice bran (FFRB) or defatted rice bran (DFRB) fed to gestating sows[1]

Item	3.5 × maintenance ME			1.5 × maintenance ME			SEM	*P*-value		
	Basal	FFRB	DFRB	Basal	FFRB	DFRB		Diet	Intake level	Diet × intake level
Feed intake, kg/d	6.11	6.29	6.83	2.75	2.75	3.32	0.25	0.034	< 0.001	0.935
Intake of GE, kcal/d	23,368	26,795	26,017	10,530	11,755	12,659	1,088	0.036	< 0.001	0.525
GE in feces, kcal/d	2,632[b]	4,015[a]	4,371[a]	1,223[d]	1,756[cd]	2,083[bc]	194	< 0.001	< 0.001	0.048
GE in urine, kcal/d	987	610	676	467	410	524	112	0.049	< 0.001	0.080
ATTD of GE, %	88.65	84.87	83.26	88.49	85.07	83.54	0.70	< 0.001	0.855	0.947
ATTD of DM, %	88.52	82.52	80.88	87.99	82.62	80.51	0.81	< 0.001	0.657	0.901
ATTD of OM, %	91.02	87.01	87.38	90.90	87.09	87.43	0.52	< 0.001	0.995	0.980
ATTD of NDF, %	70.55	48.80	51.38	70.41	49.22	52.27	2.41	< 0.001	0.910	0.550
DE, kcal/kg	3,385	3,615	3,171	3,379	3,624	3,182	27	< 0.001	0.847	0.946
ME, kcal/kg	3,226	3,516	3,072	3,206	3,474	3,029	35	< 0.001	0.181	0.910

[a–d]Means within a row with different superscripts differ.

[1]Data are means of 8 observations per treatment.

Effects of Level of Feed Intake on DE and ME in Gestating Sows

Intake of GE was greater ($P < 0.05$) if sows were fed 3.5 × the maintenance ME requirement than if they were fed 1.5 × the maintenance requirement ME and sows fed diets containing FFRB or DFRB consumed more ($P < 0.05$) GE than sows fed the basal diet (Table 3).

An interaction ($P < 0.05$) between diet and feeding level was observed for GE excreted in feces. If sows were fed 3.5 × the maintenance ME requirement, GE in feces was greater ($P < 0.05$) for sows fed diets containing FFRB or DFRB compared with sows fed the basal diet, but if sows were fed 1.5 × the maintenance ME requirement, only sows fed the DFRB diet had a greater ($P < 0.05$) fecal excretion of GE than sows fed the basal diet. A tendency for an interaction ($P = 0.08$) was observed for GE in urine, with greater urine output from sows fed the basal diet at 3.5 × the maintenance ME requirement than in sows fed the FFRB or DFRB diets at 3.5 × the ME requirement for maintenance, but there was no difference among diets if feed intake was 1.5 × the maintenance ME requirement. There were no effects of level of feed intake on ATTD of GE, DM, OM, or NDF or on concentrations of DE and ME in the diets, but the ATTD of GE, DM, OM, and NDF was greater ($P < 0.05$) in the basal diet than in diets containing FFRB or DFRB. However, the DE and ME were greater ($P < 0.05$) in the diet containing FFRB than in the basal diet or the diet containing DFRB regardless of intake level.

There were no effects of level of feed intake on ATTD of GE or NDF in FFRB and DFRB or on DE and ME of ingredients (Table 4). However, DE, ME, and ATTD of GE were greater ($P < 0.05$) in FFRB than in DFRB, but that was not the case for ATTD of NDF.

Effects of Physiological Stage

The daily intake of GE was greater ($P < 0.05$) in gestating sows than in growing gilts and sows and gilts fed diets containing FFRB or DFRB had greater ($P < 0.05$) daily intake of GE than those fed the basal diet (Table 5). The daily excretion of GE in feces was greater ($P < 0.05$) from sows fed diets containing FFRB or DFRB than in growing gilts fed these diets, but fecal GE excretion from both sows and gilts was greater ($P < 0.05$) if FFRB or DFRB diets were fed rather than the basal diet. Excretion of GE in urine was also greater ($P < 0.05$) in sows than in gilts and tended ($P = 0.055$) to be greater if the basal diet was fed instead of the FFRB or DFRB diets. The ATTD

Table 4. Effect of feed intake level on apparent total tract digestibility (ATTD) of GE, and NDF and concentration of DE and ME in full fat rice bran (FFRB) or defatted rice bran (DFRB) fed to gestating sows[1]

Item	3.5 × maintenance ME		1.5 × maintenance ME		SEM	*P*-value		
	FFRB	DFRB	FFRB	DFRB		Ingredient	Intake level	Ingredient × intake level
ATTD of GE, %	81.49	77.03	81.34	78.48	1.46	0.006	0.955	0.960
ATTD of NDF, %	36.68	37.96	30.49	42.36	4.02	0.108	0.821	0.188
DE, kcal/kg DM	4,168	3,241	4,185	3,224	82	< 0.001	0.999	0.824
ME, kcal/kg DM	4,119	3,228	4,062	3,158	85	< 0.001	0.469	0.940

[1]Data are means of 8 observations per treatment.

Table 5. Effects of the physiological stage on the apparent total tract digestibility (ATTD) of GE, DM, OM, and NDF and concentrations of DE and ME of the basal diet and diets containing full fat rice bran (FFRB) or defatted rice bran (DFRB) and fed to gestating sows or growing gilts at 3.5 × the estimated ME requirement for maintenance[1]

	Gestating sows			Growing gilts				*P*-value		
Item	Basal	FFRB	DFRB	Basal	FFRB	DFRB	SEM	Diet	Stage	Diet × stage
Feed intake, kg/d	6.11	6.29	6.83	2.11	2.23	2.57	0.26	0.066	< 0.001	0.873
Intake of GE, kcal/d	23,368	26,795	26,017	8,092	9,511	9,846	1,016	0.036	< 0.001	0.600
GE in feces, kcal/d	2,632[b]	4,015[a]	4,371[a]	1,006[d]	1,625[c]	1,815[c]	192	< 0.001	< 0.001	0.027
GE in urine, kcal/d	987	610	676	298	278	267	92	0.055	< 0.001	0.106
ATTD of GE, %	88.65	84.87	83.26	87.62	82.89	80.92	0.58	< 0.001	< 0.001	0.514
ATTD of DM, %	88.52	82.52	80.88	88.89	82.54	80.5	0.50	< 0.001	0.892	0.887
ATTD of OM, %	91.02[a]	87.01[bc]	87.38[c]	90.40[a]	85.60[b]	84.00[d]	0.49	< 0.001	0.005	0.004
ATTD of NDF, %	70.55	48.80	51.38	65.81	46.34	48.96	2.67	< 0.001	0.149	0.884
DE, kcal/kg	3,385	3,615	3,171	3,346	3,531	3,082	22.62	< 0.001	< 0.001	0.483
ME, kcal/kg	3,226	3,516	3,072	3,203	3,406	2,932	31.20	< 0.001	< 0.001	0.168

[a–d]Means within a row with different superscripts differ.

[1]Data are means of 8 observations per treatment.

of GE, DM, and NDF of diets containing FFRB or DFRB was less ($P < 0.05$) than of the basal diet, regardless of the physiological stage of the animals. The ATTD of GE of diets was greater ($P < 0.05$) in gestating sows than in growing gilts, but the ATTD of DM and NDF was not influenced by the physiological stage of the animals. The ATTD of OM was also greater ($P < 0.05$) for the basal diet than for the other diets for both gilts and sows, but for sows, no differences between FFRB and DFRB diets were observed, whereas the ATTD of OM was greater for FFRB than for DFRB if diets were fed to gilts (interaction, $P < 0.05$). The concentrations of DE and ME in diets were greater ($P < 0.05$) for gestating sows than for gilts, but for both groups of animals, the DE and ME were greater for the FFRB diet than for the other diets.

The ATTD of GE and the concentrations of DE and ME in FFRB and DFRB were greater ($P < 0.05$) in gestating sows than in gilts and also greater ($P < 0.05$) in FFRB than in DFRB (Table 6). However, the ATTD of NDF for FFRB and DFRB was not affected by the physiological stage of the animals.

DISCUSSION

The analyzed composition of corn and soybean meal used in this experiment are in agreement with reported values (Sauvant et al., 2004; NRC, 2012; Casas and Stein, 2016). However, the concentration of AEE in FFRB was greater than previous values, whereas the concentration of starch in FFRB and DFRB was slightly less than reported (Sauvant et al., 2004; NRC, 2012; Casas and Stein, 2016). Variation in the milling of rice or extraction of oil from the bran may be the reason for the variation in composition among sources of rice bran because different amounts of endosperm or oil may remain in the final product (Saunders, 1985).

Values for ATTD of GE and nutrients and values for DE and ME in most feed ingredients have been obtained in growing pigs that were provided feed at a level that was close to the voluntary feed intake of the animals (Le Goff and Noblet, 2001). However, results of experiments conducted to evaluate effects of level of feed intake on digestibility of energy and nutrients in growing pigs are contradictory and may not always be applicable if gestating sows are provided a limited amount of feed (Le

Table 6. Effects of the physiological stage on the apparent total tract digestibility (ATTD) of GE and NDF and concentrations of DE and ME in full fat rice bran (FFRB) and defatted rice bran (DFRB) fed to gestating sows or growing gilts at 3.5 × the estimated ME requirement for maintenance[1]

	Gestating sows		Growing gilts			*P*-value		
Item	FFRB	DFRB	FFRB	DFRB	SEM	Ingredient	Stage	Ingredient × stage
ATTD of GE, %	81.49	77.03	78.06	73.45	1.40	0.003	0.019	0.957
ATTD of NDF, %	36.68	37.96	30.49	38.68	4.32	0.280	0.539	0.438
DE, kcal/kg DM	4168	3241	3975	3058	67	< 0.001	0.009	0.940
ME, kcal/kg DM	4119	3228	3871	2933	81	< 0.001	0.002	0.773

[1]Data are means of 8 observations per treatment.

Goff and Noblet, 2001). The observation in this experiment that values for digestibility of GE and nutrients in gestating sows were not influenced by feeding level concurs with previous reports that concluded that ATTD of GE is not different if growing pigs are fed at 1, 2, or 3 times the ME requirement for maintenance (Haydon et al., 1984; Moter and Stein, 2004). However, results of this experiment contrast data reported by Chastanet et al. (2007) and Oresanya et al. (2008) who observed a decline in digestibility if pigs were allowed ad libitum intake of feed compared with pigs that were restricted in their intake. Feeding gestating sows approximately 1.5 times the maintenance requirement is a common practice under commercial conditions, but results of this experiment indicate that this does not change DE and ME values of diets compared with animals allowed greater levels of feed intake. Thus, it appears that the retention time of digesta in sows is sufficient to maximize digestion and fermentation regardless of the level of feed intake.

Greater digestibility of nutrients by sows compared with growing pigs has been reported (Fernández et al., 1986, Le Goff and Noblet, 2001; Lowell et al., 2015), but previous data were obtained using sows restricted in their feed intake and growing pigs allowed to consume feed in greater quantities. As a consequence, we hypothesized that effects of intake level and the physiological stage may have been confounded. However, the observation that level of feed intake does not influence DE and ME in sows demonstrates that there is a physiological difference between sows and growing pigs that allow sows to obtain more energy from feed regardless of the level of feed intake. The increased ATTD of GE and the increased DE and ME in diets fed to sows have been explained by greater digestive capacity, slower rate of passage, and more efficient fermentation of fiber in the large intestine (Noblet and van Milgen, 2004). However, the observation that the ATTD of NDF was not greater in sows than in growing pigs indicates that it may not be the fiber fraction that resulted in improved ATTD of GE in sows. This conclusion is in agreement with data by Lowell et al. (2015) and the exact reason for the greater ATTD of GE and DM that is observed in sows compared with growing gilts remains to be elucidated. However, it is possible that starch or lipids are more efficiently digested in sows than in growing pigs, but use of ileal cannulated animals is required to test this hypothesis.

Values for ATTD of GE and the concentration of DE and ME in FFRB and DFRB that were obtained in this experiment for growing pigs concur with previous values for growing pigs (Warren and Farrell, 1990; Casas and Stein, 2016). Likewise, the greater concentration of ME in FFRB than in DFRB agrees with previous data (Warren and Farrell, 1990; Casas and Stein, 2016) and likely is explained by the greater concentrations of AEE in FFRB compared with DFRB. However, to our knowledge there are no previous values for ATTD of GE or concentrations of DE and ME in FFRB and DFRB fed to gestating sows, but the present data indicate that both ingredients are well utilized by sows.

Conclusions

The first hypothesis for this work was that sows fed 3.5 × the maintenance requirement for ME will have reduced DE and ME compared with sows fed 1.5 × the maintenance requirement for ME. However, we had to reject this hypothesis because results indicated that the level of intake of feed does not affect the ATTD of GE, DM, OM, or NDF or the concentration of DE and ME of a corn-soybean meal diet or diets containing FFRB or DFRB. The second hypothesis was that if both sows and growing gilts are fed at 3.5 × the maintenance requirement for ME, no differences in DE and ME between sows and gilts will be observed. We also rejected this hypothesis because results demonstrated that concentrations of DE and ME in a corn-soybean meal diet and in diets containing FFRB or DFRB and in FFRB and DFRB are greater if fed to gestating sows than to growing gilts even if the level of feed intake is the same. Therefore, it is concluded that there are physiological differences between gestating sows and growing gilts that result in sows having greater DE and ME of diets than growing gilts. However, it does not appear that the greater digestibility of energy in sows than in gilts is a result of increased fermentation of fiber.

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