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EFFECTS OF BIRTH WEIGHT AND POSTNATAL HIGH-FAT DIET ON GROWTH PERFORMANCE, CARCASS AND MEAT QUALITY IN PIGS

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ABSTRACT

The current study was conducted to investigate the effects of birth weight and postnatal high-fat (HF) diet fed to pigs on growth performance, carcass composition, and meat quality traits. Twenty normal birth weight (NBW) and twenty intrauterine growth retarded (IUGR) barrows were fed a control diet or a HF diet from weaning to slaughter. IUGR pigs had a lower average daily gain and feed intake than NBW pigs. At slaughter, dressing yield decreased, whereas *longissimus* muscle (LM) area and back fat thickness increased in IUGR pigs compared with NBW pigs. The pH_{45min}, lightness (L*), cooking loss, drip loss, and activity of glucose-6-phosphate dehydrogenase (G6-PDH) in LM were reduced in IUGR pigs than NBW pigs. Moreover, IUGR pigs exhibited greater intramuscular fat (IMF) content, yellowness (b*), Warner-Bratzler shear force, and activity levels of fatty acid synthase (FAS) compared to NBW pigs. The IMF and activity levels of G6-PDH were higher in LM of pigs fed a HF diet than pigs fed a control diet. In addition, HF feeding depressed FAS and malic enzyme activity. The interactions between birth weight and postnatal diet for LM area, back fat thickness, $pH_{45min,}$ and IMF in LM were observed in this study. In conclusion, our results suggested that IUGR pigs had a greater ability to deposit lipid in adipose tissue and skeletal muscle than NBW pigs when fed a HF diet, while producing less tender meat than NBW pigs.

Key words: birth weight; high-fat diet; meat quality; pig.

INTRODUCTION

Intrauterine growth retardation (IUGR), characterized by abnormal growth and development of the fetus during pregnancy, is a major threat to the livestock production (Wu *et al.*, 2006). During the past decades, improvements in genetic selection and feeding management have been introduced in pig production. However, there are still 15-20% of newborn piglets affected by IUGR (Wu *et al.,* 2006). Previous studies showed that fetal growth restriction during pregnancy reduced postnatal growth and the efficiency of feed utilization, exhibited a lower total number of muscle fibers, increased lipids deposition, and impaired meat quality in pigs (Bee, 2004; Gondret *et al.,* 2006; Bérard *et al.,* 2008). Nonetheless, the relationships between birth weight and muscle development, and subsequent meat quality, were not observed in some experiments (Gondret *et al.,* 2005; Rehfeldt *et al.,* 2008; Beaulieu *et al.,* 2010). Interfering factors such as competition between piglets and differences in feeding levels may account for the inconsistent results.

Epidemiological studies have revealed that postnatal nutrition is associated with increased risk of maternal programming metabolic dysfunctions like obesity, type 2 diabetes, abnormal lipid metabolism, and coronary heart disease (Godfrey and Barker, 2000). Although previous studies from animal science have reported the effect of IUGR on carcass and meat quality in pigs, postnatal nutrition was not taken into consideration in these researches (Bee, 2004; Gondret *et al.,* 2005; Gondret *et al.,* 2006; Bérard *et al.,* 2008). It has been demonstrated that mitochondrial function was impaired in skeletal muscle of IUGR offspring, which could affect subsequent glycolytic process and energy metabolism, and ultimately meat quality (Hamilton *et al.*, 2003).

The developing mammalian fetus could anticipate postnatal environment and produce a matched phenotype according to the nutritional status during pregnancy period, thus increasing the fitness of the organism (Gluckman *et al.,* 2008). There are extensive experimental data suggesting that the responses of the offspring to postnatal nutritional and hormone challenges were dependent on maternal nutritional status during pregnancy (Morris *et al.*, 2009). Mitochondrial dysfunction and altered meat quality have been shown to concur with high-fat diet intake (Jørgensen *et al.*, 2009). Furthermore, it has been reported that IUGR altered the responses of pigs to high-fat diet-induced mitochondrial dysfunction in skeletal muscle (Liu *et al.*, 2012). The effect of postnatal high-fat diets on mitochondrial function may lead to alterations in subsequent lipid metabolism and meat quality. Therefore, the objective of this study was to test whether variations in piglets' birth weight, influenced postnatal growth performance, lipogenic enzymes activities, and meat quality in response to postnatal high fat intake from weaning to slaughter.

MATERIALS AND METHODS

Animals and treatments: The experimental protocols of this study were approved by the Animal Care Advisory Committee of Southwest University of Science and Technology. Twenty normal birth weight (NBW) and twenty intrauterine growth retardation (IUGR) male piglets (Duroc × Landrace × Yorkshire) were used in the present study. After farrowing, the birth weight of each piglet was recorded. NBW and IUGR piglets could be defined followed the following criteria, NBW: birth weight > 1.4 kg and IUGR: birth weight < 1.1 kg (Liu *et al*. 2011). At weaning (day 28), a total of twenty NBW and twenty IUGR male pigs were allotted to control diet (C) and high fat diet (HF) groups on the basis of nearly equalized weight. This producing 4 experiment groups (birth weight/diet); NBW/C, NBW/HF, IUGR/C, and IUGR/HF (n = 10 per group). The diet (Table 1) was formulated to meet or exceed the nutrient requirements of pigs (NRC, 2012). The C and HF diets were different in fat, and carbohydrate content. The formulas of diets were changed along growth period from weaning to slaughter.

Slaughter procedure and tissue sampling: All pigs were killed by electrical stunning and exsanguinations at approximately 110 kg of body weight. Approximately 5 g of *longissimus* muscle (LM) sample was collected from the LM between 6th and 7th rib immediately after slaughter for biochemical analyses. Dressing yield was calculated according to hot carcasses weight and slaughter weight. Midline backfat depth at the first rib, last rib, and last lumbar vertebra were recorded to measure mean backfat thicknesses. The area of the LM was measured using a compensating planimeter after the right side of the carcass was ribbed between the 7th and 8th rib.

Meat-quality analyses: Four 2.5 cm-thick LM sample chops were collected between the 7th and 8th rib interface. The L* (lightness), a* (redness), and b*(yellowness) values in first LM chop were determined using a Minolta Chromameter CR-300 (Minolta, Osaka, Japan) by three persons according to the pork color standards (Japanese Color Standards, Nakai, Japan) immediately after slaughter. The second chop was used to determine drip loss based on the difference in sample weight after being suspended in a Whirl-pak bag at 4ºC for 24h. The Warner–Bratzler shear force (WBSF) of the third chop LM sample was determined according to the methods as we described previously (Tang *et al.*, 2009). The cooking loss in the forth LM samples were determined by heating the samples in a water bath at 70ºC after being vacuum-packed. Furthermore, three gram LM sample was homogenized with 5 ml pure water, and the pH values were measured at 45min and 24h after slaughter using a pH metre (PHS-3D, Shanghai REX Instrument Factory, China).

Biochemical analyses: The intramuscular fat (IMF) content in LM was determined using the total lipids extraction method (Folch *et al.*, 1957). The activities of lactate dehydrogenase (LDH), fatty acid synthase (FAS), malic enzyme (ME), and glucose-6-phosphate dehydrogenase (G6-PDH) were determined in the LM of pigs. Weighed amounts of samples (approximately 2 g) were homogenized in cold 0.25 M sucrose buffer containing 1 mM dithiothreitol, 1 mM EDTA, and protease inhibitors (Bazin and Ferré, 2001). After being centrifuged at 30,000 × *g* at 4 ºC for 60 min, the supernatant was obtained for enzyme activities assay of LDH, FAS, ME, and G6-PDH using NADPH as an oxidative substrate by the spectrophotometric method at 340 nm as described previously (Oksbjerg *et al.*, 1995; Kouba *et al.*, 1999; Bazin and Ferré, 2001).

Statistical analyses: Statistical analyses were carried out using SAS statistical packages (SAS Institute, Cary, NC, USA). Difference between groups was determined using the MIXED procedures of SAS version 9.1. The statistical model included the effects of the diets (control or high fat), birth weight (NBW or IUGR), and their interaction. Data are presented as mean ± pooled SEM. Differences were considered significantly when $P < 0.05$.

RESULTS AND DISCUSSION

Growth performance: Regardless of dietary treatment, IUGR pigs grew slower than NBW pigs in each growth periods of the current study ($P < 0.01$). This maybe directly caused by the decreased average daily feed intake (ADFI) ($P < 0.01$). The feed conversion ratio (F:G) was elevated in IUGR pigs compared with NBW pigs ($P < 0.01$). As expected, consumption of a HF diet from weaning to slaughter reduced the ADFI and also increased feed conversion ratio ($P < 0.01$). There was no interactive effect of birth weight × diet on ADG, ADFI, and feed conversion ratio at each stage ($P > 0.05$).

Carcass quality: Compared with NBW pigs, IUGR decreased dressing yield and increased mean backfat depth and area of LM at the same slaughter weight, respectively ($P < 0.01$). Furthermore, the area of LM ($P < 0.01$) and backfat thickness ($P = 0.092$) were affected by the interaction of birth weight and postnatal HF diet. This interaction showed that the area of LM and backfat thickness were similar between NBW pigs fed a control diet or a HF diet, while IUGR pigs fed a HF diet had a greater area of LM and backfat thickness than IUGR pigs fed a control diet.

Meat quality: The pH of the LM, measured at 45 min post mortem, was increased by IUGR (P < 0.01), regardless of postnatal diet. However, this trait was not influenced by birth weight and dietary treatment when measured at 24 h post mortem (P > 0.05). By contrast, the L*, cooking loss, and drip loss in the LM were lower in IUGR pigs than in NBW littermates (P < 0.01), while b* value increased (P < 0.05). There was an interactive effect of birth weight × diet on L* in the LM of pigs (P < 0.05). Pigs fed a HF diet had a greater a* value in the LM than that of pigs fed a control diet (P < 0.01). Intramuscular fat content in LM was increased by IUGR and HF feeding (P < 0.01). Moreover, an interactive effect of birth weight × diet on IMF was observed in this study (P < 0.01), which demonstrated that IUGR pigs fed a HF diet increased IMF content in LM than that in IUGR pigs fed a control diet, while no difference was observed in LM of NBW pigs fed a control diet or a HF diet. The WBSF of LM was lower in IUGR pigs compared with NBW pigs (P < 0.01), regardless of postnatal HF diet.

Enzymes activities: The activity of G6-PDH in the LM of pigs was enhanced by HF feeding, while fatty acid synthase and malic enzyme activities were reduced (P < 0.01). Moreover, IUGR increased fatty acid synthase activity (P < 0.01) and reduced G6-PDH activity (P < 0.01), respectively. No effect of birth weight, HF diet and interaction was observed in lactate dehydrogenase activity of the LM in this study (P > 0.05).

In the present study, we examined the hypothesis that IUGR pigs with a lower birth weight exhibit different alterations in carcass and meat quality traits compared to NBW pigs in response to postnatal HF feeding. To test this hypothesis the pigs with different birth weight were fed a control diet or a HF diet (supplemented with 10% lard) from weaning to slaughter at the same body weight. Consistent with the results from previous studies (Bee, 2004; Bérard *et al.,* 2008; Rehfeldt *et al.,* 2008), our findings showed that IUGR leads to decreased ADG and ADFI and increased feed conversion ratio regardless of diet type. However, consumption of the HF diet from weaning to slaughter induced different changes in the carcass and meat quality traits between IUGR and NBW pigs. There were consistent effects of IUGR on the meat quality of pigs with earlier studies (Gondret *et al.*, 2006; Rehfeldt *et al.,* 2008), and we suggested that IUGR pigs had a greater ability to deposit lipid in adipose tissue and muscle than NBW pigs when fed a HF diet.

Inadequate nutrient intake of the fetus during pregnancy is considered to be the main cause of IUGR and is associated with impaired appetite and muscle development (Foxcroft *et al.,* 2006; Wu *et al.,* 2006). The data of the present study showed that IUGR reduced postnatal growth rate by decreasing the feed intake of pigs compared with NBW littermates. Furthermore, feed conversion rate was significantly lower for IUGR than for NBW pigs, which is directly caused by the decreased daily nutrients intake. Consumption of a HF diet from weaning to slaughter has beneficial improvement on the growth rate of both NBW and IUGR pigs. This might be explained by the digestible energy levels of HF diets exceed the requirement of pigs suggested by NRC (2012). Additionally, the feed conversion rate was improved by the HF feeding because the digestible energy concentrations of HF diets were clearly higher than that of control diets.

In a previous study, it has been reported that pigs with low birth weight had greater lipid content in skeletal muscle and backfat production compared to NBW pigs (Gondret *et al.,* 2006). In agreement with data reported previously, the current study found that IMF in LM and mean backfat depth were increased in IUGR pigs compared to NBW littermates, which might be explained by enlarged adipocyte diameters and greater proportion of small adipocytes in skeletal muscle and adipose tissue of IUGR offspring (Jones and Friedman, 1982). We suggest that these differences in fat deposition associated with birth weight were related to changes in lipogenic enzyme activities. In the present study, the activity of glucose-controlled lipogenic enzyme, fatty acid synthase (FAS), was upregulated in LM of IUGR pigs, which is in agreement with the increased activity of FAS and malic enzyme in adipose tissue of pigs with low birth weight as reported previously (Gondret *et al.*, 2006). Moreover, the reduced activity of G6-PDH in LM of IUGR pigs revealed the abnormal glucose metabolism in skeletal muscle was consistent with our previous study (Liu *et al.*, 2012), which might provide a possible explanation for poor glucose tolerance in pigs with low birth weight compared with NBW pigs (Poore *et al.,* 2002). It is noteworthy that consumption of a HF diet depressed activity of lipogenic enzyme in LM, whereas backfat deposition and IMF content were increased in IUGR pigs fed a HF diet than IUGR pigs fed a control diet, while no difference in backfat thickness and IMF was observed in NBW pigs fed different diets. Our results directly demonstrated that IUGR pigs have a greater ability of lipid deposition than NBW pigs when a HF diet was provided, which support the growing evidences of epidemiological researches suggesting that IUGR increases the susceptibility of offspring compared to HF diet-induced metabolic syndrome (Rueda-Clausen *et al.*, 2011). The dietary energy cannot be used for muscle accretion and is mainly used for fat deposition, which might explain the increased backfat deposition in IUGR pigs compared to their NBW littermates in the current study. Interestingly, consumption of a HF diet from weaning to slaughter increased area of LM in IUGR pigs and had no effect on this trait in NBW pigs, which means that dietary protein used for muscle synthesis in LM was affected by birth weight. Pigs fed a HF diet had a reduced dietary protein to energy ratio, and this should lead to impaired protein deposition for muscle development. However, this HF feeding elevated LM production in IUGR pigs and induced no effect in NBW pigs cannot be explained by us. Further investigations are needed to confirm or disprove this observation.

There were several studies that reported the influence of birth weight on the meat quality traits, but some discrepancy existed (Bee, 2004; Gondret *et al.*, 2006; Bérard *et al.*, 2008). In the present study, IUGR pigs had a lower pH_{45min} compared to NBW pigs and no effect of the HF diet on pH_{45min} and pH_{24h} was observed. Although the fast pH decline often associated with increased L* and drip loss, Nissen and Oksbjerg (2011) reported no impact of the pH_{45min} on L* and drip loss was found in skeletal muscle of pigs. In agreement, our results showed that the L* and drip loss were reduced in LM of IUGR pigs compared to NBW pigs, while the pH_{45min} decreased. Furthermore, in accordance with the negative relationship between lipid content and drip loss (Gondret *et al.*, 2006), the decreased drip loss of LM may be caused by the increased fat deposition in LM in the present study. LDH plays a central role in the production of lactic acid post mortem, and an increased activity leads to a faster pH decline (Monin and Sellier, 1985). There was no difference in the activity of LDH in LM between IUGR and NBW pigs, which cannot explain the lower pH_{45min} in IUGR pigs in this study. Our results found that greater values of b* in the LM of IUGR pigs compared to NBW littermates. This might be explained by the understanding that IUGR pigs have more oxidative glycolytic myofibers (Bee, 2004), which have higher myoglobin content (Lefaucheur, 2001), thus leading to a darker of LM.

The tenderness is one of the important traits of meat quality and was measured by Warner-Bratzler shear force (WBSF) in the current study. Consistent with previous reports (Gondret *et al.*, 2005, 2006; Bérard *et al.*, 2008), our findings showed that IUGR pigs had a lower tenderness of the LM than that of NBW pigs, reflected by an increased shear force. Indeed, the tenderness of meat was highly related to the cross-sectional area of myofibers. Other studies have demonstrated that IUGR pigs had greater mean myofibers diameters in the skeletal muscle compared with their normal littermates (Bee, 2004; Gondret *et al.*, 2005). Altogether, our results agree with earlier studies showing a decreased tenderness of meat in pigs with a low birth weight (Gondret *et al.*, 2006; Bérard *et al.*, 2008).

Table 1. Composition and nutrient content of experimental diets (as-fed basis).

Diet feeding period	**5-8 weeks**		**9-12 weeks**		**13-20 weeks**		**21 weeks-110 kg**	
Dietary level of fat	C*	HF†	C	HF	C	HF	C	HF
Ingredients [%]								
Corn	49.50	49.50	56.27	56.27	61.65	61.65	64.38	64.38
Decupled soybean meal	13.50	13.50						
Soybean meal			23.55	23.55	18.50	18.50	16.60	16.60
Cornstarch	10.00		10.00		10.00		10.00	
Lard		10.00		10.00		10.00		10.00
Fish meal	2.00	2.00	2.50	2.50	2.50	2.50	2.00	2.00
Whey powder	10.00	10.00						
Bran			5.00	5.00	5.00	5.00	5.00	5.00
Plasma protein	2.00	2.00						
Soybean protein concentrate	10.00	10.00						
Sodium chloride	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Choline chloride	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Limestone	0.80	0.80	0.60	0.60	0.60	0.60	0.60	0.60
Dicalcium phosphate	1.20	1.20	1.10	1.10	0.80	0.80	0.50	0.50
L-lysine	0.15	0.15	0.13	0.13	0.10	0.10	0.07	0.07
Premix#	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analyzed nutrient and calculated energy levels								
Digestible energy [MJ/kg]	14.33	16.13	14.00	15.79	14.00	15.80	14.04	15.84
Crude protein [%]	19.3	19.9	18.2	17.7	16.5	16.1	14.7	15.2
Ca [%]	0.84	0.88	0.78	0.73	0.66	0.61	0.56	0.53
P [%]	0.61	0.65	0.62	0.58	0.54	0.55	0.47	0.42

Note: *C, control diet, without lard supplemented; †HF, high-fat diet, supplemented with 10% lard; #Provided per kg of diet: Vitamin A, 5512 IU; Vitamin D_3, 2250 IU; Vitamin E, 24 mg; Vitamin K_3, 3 mg; Vitamin B_1, 1.5 mg; Vitamin B_2, 6 mg; Vitamin B_6, 3 mg; Vitamin B_{12}, 0.024 mg; Nicotonic, 20 mg; Pantothenic, 15 mg; Biotin, 0.15 mg; Folic acid 1.2 mg; Fe, 120 mg; Cu, 17 mg; Zn, 120 mg; Mn, 25 mg; Se, 0.2 mg; I, 0.3 mg.

Table 2. Effects of birth weight and postnatal high-fat diet on growth performance of pigs in various time periods of growth.

Items	NBW[#]		IUGR[§]			*P - value*		
	C[*]	HF[†]	C	HF	SEM	BW[※]	Diet	I[φ]
5 – 8 weeks								
ADG [g/d]	513	528	321	327	21.0	<0.01	0.625	0.829
ADFI [g/d]	984	865	663	623	40.7	<0.01	<0.05	0.346
F:G	1.92	1.63	2.04	1.92	0.04	<0.01	<0.01	0.072
9 -12 weeks								
ADG [g/d]	904	856	663	648	26.0	<0.01	0.234	0.534
ADFI [g/d]	1709	1474	1166	1063	54.2	<0.01	<0.01	0.229
F:G	1.89	1.72	1.75	1.64	0.04	<0.01	<0.01	0.405
ADG [g/d]	870	1048	798	859	15.1	<0.01	<0.01	<0.01
ADFI [g/d]	2684	2299	2277	1846	51.5	<0.01	<0.01	0.661
F:G	3.09	2.19	2.87	2.15	0.08	0.091	<0.01	0.249
17 -20 weeks								
ADG [g/d]	929	1054	821	898	19.2	<0.01	<0.01	0.218
ADFI [g/d]	2792	2573	2361	2053	45.2	<0.01	<0.01	0.335
F:G	3.01	2.45	2.88	2.29	0.06	<0.01	<0.01	0.647
21 weeks – 110 kg								
ADG [g/d]	933	1142	748	870	24.8	<0.01	<0.01	0.089
ADFI [g/d]	2677	2481	2362	2182	46.8	<0.01	<0.01	0.867
F:G	2.88	2.19	3.16	2.51	0.07	<0.01	<0.01	0.807

Note: [*]C, control diet, without lard supplemented; [†]HF, high-fat diet, supplemented with 10% lard; [#]NBW, normal birth weight; [§]IUGR, intrauterine growth retardation; [※]BW, birth weight; [φ]I, Interaction.

Table 3. Effects of birth weight and postnatal high-fat diet on carcass traits of pigs.

Items	NBW[#]		IUGR[§]			*P - value*		
	C[*]	HF[†]	C	HF	SEM	BW[※]	Diet	I[φ]
Dressing yield [%]	66.71	65.93	64.01	63.52	0.61	<0.01	0.706	1.000
Loin muscle area [cm^2]	38.14	35.79	43.14	48.27	1.59	<0.01	0.342	<0.01
Back fat thickness [cm]	2.10	2.11	2.35	2.61	0.07	<0.01	0.163	0.092

Note: [*]C, control diet, without lard supplemented; [†]HF, high-fat diet, supplemented with 10% lard; [#]NBW, normal birth weight; [§]IUGR, intrauterine growth retardation; [※]BW, birth weight; [φ]I, Interaction.

Table 4. Effects of birth weight and postnatal high-fat diet on meat quality traits of pigs.

Items	NBW[#]		IUGR[§]			*P - value*		
	C[*]	HF[†]	C	HF	SEM	BW[※]	Diet	I[φ]
pH_{45min}	6.58	6.63	6.51	6.49	0.05	<0.01	0.848	0.083
pH_{24h}	5.74	5.81	5.77	5.80	0.04	0.266	0.599	0.599
Intramuscular fat [%]	3.37	3.19	3.63	4.59	0.20	<0.01	<0.01	<0.01
Lightness	44.26	44.43	41.21	39.68	0.33	<0.01	0.124	<0.05
Redness	6.03	7.29	6.32	7.98	0.41	0.136	<0.01	0.724
Yellowness	2.07	2.05	2.51	2.70	0.25	<0.05	0.931	0.669
Cooking loss [%]	35.85	35.23	34.37	34.11	0.35	<0.01	0.377	0.371
Drip loss [%]	3.21	3.23	1.84	1.75	0.20	<0.01	0.420	0.414
WBSF[▲] [kg]	4.83	4.78	5.62	5.59	0.16	<0.01	0.823	0.918

Note: [*]C, control diet, without lard supplemented; [†]HF, high-fat diet, supplemented with 10% lard; [#]NBW, normal birth weight; [§]IUGR, intrauterine growth retardation; [※]BW, birth weight; [φ]I, Interaction; [▲]WBSF, Warner-Bratzler shear force.

Table 5. Effects of birth weight and postnatal high-fat diet on enzyme activities in *longissimus* muscle of pigs.

Items [nmol/min/g tissue]	NBW[#]		IUGR[§]			*P - value*		
	C[*]	HF[†]	C	HF	SEM	BW[※]	Diet	I[φ]
Fatty acid synthase	31.4	18.2	33.6	24.6	1.7	<0.05	<0.01	0.260
Malic enzyme	293.0	231.3	315.2	217.5	14.1	0.779	<0.01	0.231
G6-PDH[▲]	58.2	77.4	36.3	63.2	5.8	<0.01	<0.01	0.567
Lactate dehydrogenase	1691.3	1602.5	1783.2	1646.0	150.3	0.674	0.458	0.871

Note: [*]C, control diet, without lard supplemented; [†]HF, high-fat diet, supplemented with 10% lard; [#]NBW, normal birth weight; [§]IUGR, intrauterine growth retardation; [※]BW, birth weight; [φ]I, Interaction; [▲]G6-PDH, glucose-6-phosphate dehydrogenase.

Conclusions: In conclusion, although the growth rate and most traits of carcass and meat quality were affected by birth weight independent of HF diet, IUGR pigs had a greater ability to deposit lipid in skeletal muscle and adipose tissue than their NBW littermates when fed a HF diet from weaning to slaughter. Such finding is in agreement with our hypothesis that the birth weight of pigs changes the traits of meat quality response to HF diets, which provides strong evidence to support the fetal programming effects contribute to the variability in response to nutritional interventions.

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