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RESEARCH ARTICLE

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Effect of breed, sex and birth parity on growth, carcass and meat quality in pigs

Abstract The effects of breed, sex and birth parity on the traits of growth, carcass and meat quality were investigated in three different breeds including Swedish Landrace, British Large White and an indigenous Chinese breed – Tongcheng pigs. The results indicated that the Swedish Landrace and the British Large White had advantages over the Tongcheng pigs in growth rate, feed conversion rate (FCR) and carcass traits, but had disadvantages in meat quality. In contrast to the British Large White, the Swedish Landrace had higher average daily gain during the trial (ADG2) (877.04 g·day^{-1} vs. 813.95 g·day^{-1}, $P < 0.05$), and marbling score (MS) (2.48 vs. 2.02, $P < 0.01$), larger eye muscle area (EMA) (41.80 cm^2 vs. 35.14 cm, $P < 0.01$) and more efficient feed conversion rate (FCR) (3.06 vs. 3.29, $P < 0.05$), lower muscle shear force (MSF) (4.20 kgf (1 kgf = 9.80665 N) vs. 4.93 kgf, $P < 0.05$) and backfat thickness (BF) (all $P < 0.01$) including live backfat thickness (LBF), average backfat thickness at 3 points in the carcass (ABF), backfat thickness between 6th and 7th ribs (6–7 th BF) and backfat thickness at 10th rib (10 th BF). There was a difference ($P < 0.05$) only in MS between castrated females (CF) and castrated males (CM). Birth parity affected ADG2 ($P < 0.05$), some carcass characteristics and meat quality, including CL_1 ($P < 0.001$), CL_2 ($P < 0.05$), BF (ABF, 6–7th BF and 10th BF, all $P < 0.001$), EMD ($P < 0.001$), EMA ($P < 0.001$), percentage of leaf and caul fat (PLC) ($P < 0.05$), proportion of lean and bone of the ham (PLBH) ($P < 0.05$), muscle drip loss percentage (DL) ($P < 0.05$) and intramuscular fat content (IMF) ($P < 0.05$). The breed-sex interaction only impacted the average daily gain from birth to marketing (ADG1) and DL (both $P < 0.05$). However, there was no significant effect of sex-parity interaction on all the traits tested.

Keywords growth performance, carcass composition, meat quality, breed, sex, birth parity

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1 Introduction

In the recent years, the growth rate and carcass traits of pigs have been significantly improved in the Chinese swine industry, in which, exotic breeds, such as the Landrace, Large White and Duroc, play an important role. Meat quality has been increasingly emphasized in swine industry (Peng, 1994), because customers pay more and more attention to pork quality. Optimum combinations of growth rate, carcass characteristics and meat quality can increase the competitive ability of pork on the market. To realize this goal is still a challenge for swine keepers. The exotic lean type pigs have excellent performances, such as growth rate, feed conversion efficiency and percentage of lean meat. China has rich pig breed resources. Native breeds have formed specific germplasm characteristics, such as outstanding prolificacy, meat quality, and utilizable ability of coarse fodder, long period selection and breeding (Xu, 1989). Up to now, they are still playing an important role in the development of swine production. Furthermore, indigenous Chinese pig breeds are utilized in commercial programs in the western countries (Young, 1992; Lan et al., 1993; Young, 1995a, 1995b, 1995c, 1998a, 1998b; Bradley et al., 1999). The Tongcheng pig, which belongs to the Huazhong Two-end-Black breed, is a well known indigenous Chinese breed with specific advantages such as strong fitness, superior meat quality and high heterotic vigor, and is suitable for hybrid maternal lines in central China (Zhang, 1985; Xu, 1989). The Tongcheng pig was used as a dam in the breeding program of the Hubei White Pig, which is a well-known developed pig breed with high lean percentage, fast growth rate, high feed efficiency, and excellent meat quality in China (Xiong et al., 1992; Fan et al., 2006). It was collected by the domestic animal diversity information system (DAD-IS) of FAO (http://www.fao.org/dad-is) and is also listed in the key national conservation breed list of livestock and poultry in China in 2000. However, Chinese native pig breeds are in danger of being replaced by other exotic pig breeds because of their slow growth rate and high body fat content (Peng, 1994; Li et al., 2006).

It is known that the performance of pigs is determined by other genetic factors, such as sex (Lee and Kim, 2000; Peinado et al., 2003a, 2003b; Serrano et al., 2005), age and slaughter weight (Eggert et al., 1996; Peinado et al., 2003a) etc., except for breed (Eggert et al., 1996; Ball, 2000). Birth parity number of gilts has some effects on their reproductive performance as sows (Tummaruk et al., 2001). However, there are few reports about the effect of birth parity number of gilts on the production performance of the piglets.

The purpose of this paper was to describe the various growth, carcass characteristics and meat quality among different breeds (Swedish Landrace, British Large White and Tongcheng pigs), sexes (castrated boars, castrated gilts) and birth parities and to offer helpful materials for pork production.

2 Materials and methods

2.1 Experimental design

A total of 127 piglets from three breeds including the Swedish Landrace ($n = 30$), the British Large White ($n = 32$) and Tongcheng pigs ($n = 65$) were investigated in this work. Well-developed weaned piglets with similar live weights (from eight sows for the Landrace and the Large White and from sixteen sows for the Tongcheng pigs, respectively) were selected for the experiment. All the piglets were castrated before the trial. The boars were castrated at 10 days old and the oviducts were ligated for gilts at about 20–23 kg live weight. The native Chinese pig breed has early sexual maturity symptoms and a lighter adult body weight. A 75 kg body weight is commonly considered as the optimum slaughter weight. The body weight of adult boar and dams was 97 kg and 94 kg for the Tongcheng pigs, respectively (Source from the Breeds of Domestic Animal And Poultry in Hubei Province, 1985). In contrast, the exotic lean-type breed (such as the Landrace, Large White and Duroc etc.) has later sexual maturity and a heavier adult body weight. Many studies and practices revealed that the body weights of 75 kg and 90 kg were the suitable slaughter weights for Tongcheng pigs and exotic pig breeds, respectively. The growth traits were recorded from 25 to 75 kg for the Tongcheng pigs and 30 to 90 kg for the Landrace and Large White, respectively. All the pigs were slaughtered for the analysis of carcass traits and meat quality after the rearing trial. The sample information is shown in Table 1.

After weaning, all the piglets were transferred into the experimental barns and were separated by breed and sex. There were 4–5 animals per pen for each breed. During the pre-test period of a week before the test, the regular immunological program and deworming treatment were conducted for all pigs at the same time. The pigs were fed "ad libitum" during test. Diets were weighed daily and feed additions were recorded by feeders. Temperature and air relative humidity were measured and recorded at three locations (the near east, west and middle) in the barn. The diet, based on corn and soybean meal, was formulated to feed piglets. The detailed composition and nutrient levels of the diet are shown in Table 2.

2.2 Measure of growth traits

The testing procedures were carried out according to the national guidance on the technical standard of performance testing for pig breeds of the lean type (GB8467-87). The growth traits mainly included the average daily gain from birth to marketing (ADG_1), average daily gain during the trial (ADG_2), age to marketing weight (Age) and feed conversion rate (FCR). Fattening started when the body weight of piglets reached the expected value (25 kg for Tongcheng pig, 30 kg for the Landrace and Large White). All of the animals were sent to slaughter when their body weight was about 75 kg for the Tongcheng pigs and 90 kg for the Swedish Landrace & British Large White, respectively. The live weight (LW) of piglets with limosis was measured. At the same time, live backfat (LBF) was measured at three different points (A: the

Table 1 Distribution of experimental animals from different breeds, genders and birth parities

breed	total number	sex*		birth parity**
		CM	CF	
Landrace	30	10	20	1(23); 2(7)
Large White	32	16	16	1(28); 2(4)
Tongcheng pig	65	34	31	2(5); 4(4); 5(5); 7(4); 9(10); 10(9); 11(14); 12(14)

Note: * stands for CM for castrated male and CF for castrated female; ** stands for Birth parity number of sows for experimental piglets. Figures in parenthesis stands for the number of experimental piglets corresponding birth parity.

Table 2 Percentage composition and nutrient content of the experimental diet

diet composition	first stage*	late stage**
maize/%	62.0	54.0
rice/%	–	10.0
wheat bran/%	4.5	6.0
rice bran/%	9.0	12.0
soybean meal/%	16.5	10.0
premix feed/%	4.0	4.0
fish meal/%	4.0	4.0
total/%	100.00	100.00
metabolizable energy/MJ·kg^{-1}	3.12	3.05
crude protein/%	16.05	14.01
crude fiber/%	3.28	3.39
lysine/%	0.83	0.68

Note: *First stage means 25–50 kg body weight for Tongcheng pigs, 30–60 kg body weight for Swedish Landrace & British Large White; **Late stage means 50–75 kg body weight for Tongcheng pigs, 60–90 kg body weight for Swedish Landrace & British Large White.

thickest position at the shoulder; B: the position at the last rib; C: the position between the lumbar vertebra and sacrum), located at 50 mm from the centerline with ultrasonic instrument RENCO Lean-meater (RENCO Corporation, USA).

2.3 Measure of carcass traits

In the afternoon before slaughter, the pigs were mixed in one group and transported to a slaughter facility, held in one lair without food but with enough water. Animals underwent a standard commercial slaughter procedure according to the national guidance on the technical standard of performance testing for pig breeds of the lean type (GB8467-87). The left side of each carcass and main haslets including the heart, lung, liver, spleen, kidney, small intestine and large intestine were weighed. Carcass length including maximum carcass length (CL_1, from middle point at front edge of pubic symphysis to synchondrosis between 1th rib and sternum) and minimum carcass length (CL_2, from middle point at front edge of pubic symphysis to middle point at front edge of 1th cervical vertebrae) was determined using a floppy ruler. At the same time, the number of ribs (NR) was counted. Carcass backfat thickness including average carcass backfat at three points (A: the thickest position at the shoulder; B: the position at the last rib; C: the position between the lumbar vertebra and sacrum); 6–7th BF (backfat between 6th and 7th rib), 10th BF (backfat at 10th rib), skin thickness (ST), eye-muscle depth (EMD) and eye-muscle width (EMW) were measured using vernier caliper. Eye-muscle area (EMA) was calculated using classical formula method (EMA = EMD × EMW × 0.7). Furthermore, percentage of leaf fat (PLF), percentage of leaf and caul fat (PLC), percentage of ham (PH) (in the carcass) and proportion of lean and bone of the ham (PLBH) were recorded, respectively.

2.4 Measure of meat quality traits

Measurements of meat quality traits were conducted as described by Zhang (2002a, 2002b, 2002c) and Chen (2002a, 2002b). Several traits were selected in the meat quality determination. The traits of meat quality included muscle color score (MCS), pH value at 45–60 min post-mortem (pH_1), water holding capacity (water loss percentage (WL), muscle drip loss percentage (DL)), muscle shear force value (MSF), muscle marbling score (MS) and intramuscular fat content (IMF). *Longissimus dorsi* muscles between the last 4th rib and front 4th lumbar were collected for analysis of meat quality. The *longissimus dorsi* from the left side of each carcass was sent to the laboratory for further analysis. Fresh pork color and marbling scores at the cut surface of the 10–11 rib interface were evaluated within 2 h post-mortem by an experienced person. Subjective muscle color and marbling scores were reported on a 1–5 scale estimated in the Procedures to Evaluate Market Hogs (NPPC, 1991). The pH value was obtained by an Orion model 828 A pH meter within 45–60 min post-mortem. The probe was inserted in the *longissimus dorsi* muscle at the 11th rib. Three loin chops (2.5 cm × 5 cm × 3 cm) from the *longissimus dorsi* were measured for each weight (w_1) and hung in a sealed Whirl-pak bag, respectively, then stored in a cooler (4°C) for 24 h to weigh them for a second time, then re-weighed (w_2) and the drip loss ($w_1 - w_2$) was recorded. The muscle drip loss was calculated using the formula $[(w_1 - w_2)/w_1] \times 100\%$. At least triplicate samples were measured for each individual and the average value was considered as the muscle drip loss. One chop (approximately 10 g) was homogenized by getting rid of the epimysium and external fat, and then measured for intramuscular fat by phenol-chloroform extraction. Three chops (1 cm thick) were used to measure the water loss percentage. The rest of the *longissimus dorsi* was divided into three sections for measuring tenderness. Meat samples were placed at room temperature(16–18°C) for 24 h and then transferred into a 4°C cooler and allowed to age (approximately 24 h). The chops were cooked in a boiler to an internal temperature of 70°C. When the internal temperature of the chops reached 25°C, shear force was determined using a C-LM measurer developed by Chen (2002a, 2002b) from the Northeast Agricultural University. No less than 10 replicates were tested for pork tenderness of individuals, and the average value calculated was the muscle shear force value for each pig.

2.5 Statistical analysis

Formula for adjusting backfat thickness:

$$Y = \frac{y(a+bx_s)}{a+bx}, \qquad (a)$$

where Y is the adjusted backfat thickness, y is the actual backfat thickness, x_s is the standard body weight when marketing (75 kg for Tongcheng pigs, 90 kg for Swedish Landrace and British Large White), x is the actual body weight measured, a and b are the cut values and regression coefficients of x on y, respectively.

Two basic models were developed with considerations of the effects of breed, sex, birth parity, breed-sex (castrated females, CF; castrated males, CM) and sex-parity interactions for experiment animals. The effects of breed, sex and parity on growth performance, carcass and meat quality were compared using the generalized linear model procedure of SAS (SAS Institute, 1999).

The models used were:

$$Y_{ijl} = \mu + G_i + S_j + (G \times S)_{ij} + E_{ijl}; \quad \text{(b)}$$

$$Y_{jkl} = \mu + S_j + P_k + (S \times P)_{jk} + E_{jkl}, \quad \text{(c)}$$

where Y_{ijl} or Y_{jkl} = response variable; μ = overall mean response; G_i = fixed effect of breed; S_j = fixed effect of sex of piglet; P_k = fixed effect of birth parity; $(G \times S)_{ij}$ = breed × sex interaction; $(S \times P)_{jk}$ = sex × birth parity interaction; E_{jil} and E_{jkl} = residual error.

The model (b) was used for estimating the effects of breed, sex and breed-sex on performance traits with all data of 127 pigs. The model (c) was used for analyzing the impacts of sex, birth parity and sex-birth parity, only utilizing the data of Tongcheng pigs. Two different models were set up because of two reasons: (1) Limitation of sample size may affect accurate result of analysis in complicated model; (2) The actual number distribution of pigs was different in birth parity for different breed and sex. Experimental pigs came from the first and second birth parity for the Swedish Landrace and British Large White, and from more birth parities for Tongcheng pigs.

3 Results and discussion

3.1 Effects of breed on growth traits

The effects of breed on growth traits are displayed in Table 3. Tongcheng pigs had the significantly lowest average daily gain, poorest feed conversion efficiency and highest age to market (75 g for Tongcheng, 90 kg for Landrace and Large White, respectively). There was no difference in ADG1 between the Swedish Landrace and the British Large White ($P > 0.05$). However, ADG2 (877.04 g·day^{-1} vs. 813.95 g·day^{-1}, $P < 0.05$) and feed conversion efficiency (3.06 vs. 3.29, $P < 0.05$) were higher for the Swedish Landrace than the British Large White. Ball (2000) reported that the Swedish Landrace pigs had the fewest days growing to 100 kg body weight and the highest average daily gain among the Swedish Landrace, British Large White, Duroc and Hampshire.

3.2 Effects of breed on carcass traits

The Swedish Landrace had the highest loin muscle depth, percentage of ham (in the carcass), proportion of lean, bone of the ham, the largest carcass length, loin muscle area and the thinnest backfat, including live backfat thickness, average backfat thickness at 3 points in the carcass, backfat thickness between 6–7th ribs and backfat thickness at 10th rib (Table 4). Compared with the Swedish Landrace, the British Large White pigs had a lower backfat depth of about 1 mm and a larger loin muscle area, but equal backfat thickness (Ball, 2000). The Swedish Landrace had the best performance in carcass composition and the Tongcheng pig had the poorest carcass traits, but the most efficient fat deposition. However, there was no difference in the loin muscle width among the Swedish Landrace, the British Large White and the Tongcheng pigs, which indicates that the loin muscle depth may result in the difference of loin muscle area among the three different breeds.

3.3 Effects of breed on meat quality traits

No difference was found in the water holding capacity among all the tested pigs (Table 5). Ball (2000) also confirmed that there was no difference in the loin drip loss between the Swedish Landrace and the British Large White. The Swedish Landrace and the Tongcheng pig had higher pH_1 than the British Large White. Tongcheng pigs had the highest meat color score and marbling score as well as intramuscular fat content in the three breeds. No difference in the meat color score was found between the Swedish Landrace and the British Large White, which was consistent with the result reported by Eggert (1996). The Tongcheng pig had a better tenderness score. The Swedish Landrace had a higher muscle marbling score than the British Large White, but had a close meat color score and intramuscular fat content to the British Large White. It is reported that there is no difference in the loin marbling score between the Swedish Landrace and the British Large White pig (Ball, 2000).

Table 3 Effect of breed on growth traits (mean ± *SE*)

trait	Landrace	Large White	Tongcheng pig
average daily gain from birth to marketing/g	531.44 ± 8.51	518.12 ± 7.77	350.45 ± 5.41**
average daily gain during the trial/g	877.04 ± 18.77*	813.95 ± 17.13*	484.58 ± 11.93**
age to marketing weight/day	169.73 ± 3.96	173.73 ± 3.61	213.93 ± 2.52**
feed conversion rate	3.06 ± 0.05*	3.29 ± 0.04*	5.03 ± 0.08**

Note: * means $P < 0.05$; ** means $P < 0.01$.

Table 4 Effect of breed on carcass traits (mean ± *SE*)

trait	Landrace	Large White	Tongcheng pig
live weight/kg	93.58 ± 0.79	89.90 ± 0.72	74.02 ± 0.51
dressing percent/%	76.09 ± 0.34*	77.22 ± 0.31*	73.77 ± 0.21**
carcass length (Maximum)/cm	94.33 ± 0.59**	92.11 ± 0.55**	80.09 ± 0.38**
carcass length (Minimum)/cm	78.54 ± 0.45	77.47 ± 0.41	67.79 ± 0.29**
number of Rib/*n*	15.6 ± 0.1	15.7 ± 0.1	13.8 ± 0.1**
live backfat thickness/cm	1.26 ± 0.08**	1.77 ± 0.10**	3.51 ± 0.09**
average backfat thickness at 3 points in the carcass/cm	2.13 ± 0.09**	3.02 ± 0.08**	4.12 ± 0.06**
backfat thickness between 6th and 7th ribs/cm	2.04 ± 0.13**	2.88 ± 0.11**	4.28 ± 0.08**
backfat thickness at 10th rib/cm	1.84 ± 0.12**	2.34 ± 0.15**	3.67 ± 0.11**
skin thickness/cm	0.23 ± 0.02	0.28 ± 0.02	0.41 ± 0.02**
eye muscle depth/cm	10.37 ± 0.27**	9.28 ± 0.25**	5.75 ± 0.17**
eye muscle width/cm	5.75 ± 0.25	5.41 ± 0.23	5.39 ± 0.16
eye muscle area/cm^2	41.80 ± 0.62**	35.14 ± 0.57**	19.66 ± 0.39**
percentage of leaf fat/%	1.44 ± 0.17**	2.21 ± 0.15**	5.73 ± 0.11**
percentage of leaf and caul fat/%	2.98 ± 0.27*	3.75 ± 0.25*	11.08 ± 0.17**
percentage of ham (in the carcass)/%	32.35 ± 0.33*	31.16 ± 0.29*	27.91 ± 0.21**
proportion of lean and bone of the ham/%	79.74 ± 0.55**	75.34 ± 0.51**	55.39 ± 0.36**

Note: *means $P < 0.05$; ** means $P < 0.01$.

3.4 Effects of breed and breed-sex interaction on growth, carcass and meat quality traits

There was no difference ($P > 0.05$) in the growth performance between castrated females (CF) and castrated males (CM). The effects of sex were similar using the models (b) and (c), which indicated that the sex did not affect the growth performance. The performance of entire gilts and boars were not studied in this work. The differences among the genders for growth performance were confirmed, with boars having better performance on backfat, feed efficiency and lean yield (Ball, 2000). Eggert et al. (1996) reported that barrows had higher daily feed intakes and average daily gains than gilts and equal thickness of last rib backfat to gilts. The breed-sex interaction only impacted ADG1 (Table 6).

3.5 Effects of sex, breed-sex, parity-sex interaction

Table 6 shows that there were significant differences in the carcass performance between castrated males and females. Leach et al. (1996) reported that the gilts had heavier trimmed boneless ham weights compared to the barrows. Sex had only significant effects on muscle marbling and the results from models (b) and (c) were similar to each other. The breed-sex interaction had an impact on drip loss. Eggert et al. (1996) reported that there was no difference in muscle color, firmness and marbling score between barrows and gilts, but a breed-sex interaction was observed for color scores, and the result was distinct between the barrows and gilts. Other studies found little difference in muscle quality between the barrows and gilts (Barton-Gade, 1987). No difference was found for dripping or cooking losses between castrated males and females (Peinado et al., 2003a). There were fewer and smaller differences between the genders (Barrows, Gilts and Boars) for meat quality measurements than performance and carcass measurements. The largest difference in the meat quality measurements was a higher marbling score for barrows (Ball, 2000). There were no significant effects of breed-sex or parity-sex interaction on carcass traits in our study. But Eggert et al. (1996) reported that the loin muscle area was affected by the breed-sex interaction.

3.6 Effects of birth parity and parity-sex on growth, carcass and meat quality traits

There was no difference between the first and second birth parity in performance for the Swedish Landrace and the British Large White, thus the result is not displayed in

Table 5 Effect of breed on meat quality traits (mean ± *SE*)

trait	Landrace	Large White	Tongcheng pig
meat color score	3.00 ± 0.06	3.07 ± 0.06	3.26 ± 0.04**
pH value at 45–60 m postmortem	6.55 ± 0.04	6.42 ± 0.04*	6.61 ± 0.02
water loss percentage/%	12.86 ± 0.58	12.46 ± 0.53	13.41 ± 0.37
muscle drip loss percentage/%	1.79 ± 0.13	1.76 ± 0.13	1.90 ± 0.09
muscle shear force/kgf	4.20 ± 0.16	4.93 ± 0.18**	4.41 ± 0.17
marbling score	2.48 ± 0.09**	2.02 ± 0.08**	2.85 ± 0.06**
intramuscular fat content/%	1.84 ± 0.19	1.59 ± 0.18	3.78 ± 0.13**

Note: * means $P < 0.05$; ** means $P < 0.01$.

Table 6 Effects of sex, parity, breed-sex, and birth parity -sex on production performance

trait	sex	breed-sex	birth parity	birth parity-sex
average daily gain from birth to marketing/g	NO	*	NO	NO
average daily gain during the trial/g	NO	NO	*	NO
age to marker weight/day	NO	NO	NO	NO
feed conversion rate	NO	NO	NO	NO
live weight/kg	NO	NO	NO	NO
dressing percent/%	NO	NO	NO	NO
carcass length (Maximum)/cm	NO	NO	***	NO
carcass length (Minimum)/cm	NO	NO	*	NO
number of rib/n	NO	NO	NO	NO
live backfat thickness/mm	NO	NO	NO	NO
average backfat thickness at 3 points in the carcass/mm	NO	NO	***	NO
backfat thickness between 6th and 7th ribs/mm	NO	NO	***	NO
backfat thickness at 10th rib/mm	NO	NO	***	NO
skin thickness/mm	NO	NO	***	NO
eye muscle depth/cm	NO	NO	***	NO
eye muscle width/cm	NO	NO	***	NO
eye muscle area/cm^2	NO	NO	NO	NO
percentage of leaf fat/%	NO	NO	NO	NO
percentage of leaf and caul fat/%	NO	NO	*	NO
percentage of ham (in the carcass)/%	NO	NO	NO	NO
proportion of lean and bone of the ham/%	NO	NO	*	NO
meat color score	NO	NO	NO	NO
pH value at 45–60 m postmortem	NO	NO	NO	NO
water loss percentage/%	NO	NO	NO	NO
muscle drip loss percentage/%	NO	*	*	NO
muscle shear force/kgf	NO	NO	NO	NO
marbling score	**	NO	NO	NO
intramuscular fat content/%	NO	NO	*	NO

Note: NO means no significant difference; *, ** and *** mean $P < 0.05$, $P < 0.01$ and $P < 0.001$, respectively.

Table 6. The birth parity had no effect on ADG1, age to market and FCR, except for ADG2 on carcass composition, including carcass length (both maximum and carcass length, $P < 0.001$ and $P < 0.05$, respectively), backfat thickness (ABF, 6–7th BF, 10th BF), skin thickness, loin muscle depth and width, percentage of leaf and caul fat and the proportion of lean and bone of the ham in Tongcheng pig. The breed-parity interaction and effects of birth parity-sex interaction on carcass traits were not observed. However, the birth parity could affect the drip loss and intramuscular fat content (both $P < 0.05$). Actually, no effect of birth parity-sex on all detected traits in the Tongcheng pig was found. It is noted that the birth parity number of gilts as sows had an effect on their reproductive performance, such as litter size (Tummaruk et al., 2001). Up to now, however, there are few reports on the effect of birth parity number of the gilts on the production performance of their piglets. Furthermore, these results need to be further confirmed in more breeds due to the limited sample numbers in our study and few research results on the effect of birth parity by others previously.

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