Comparison of carcass traits, meat quality and expressions of MyHCs in muscles between Mashen and Large White pigs

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ABSTRACT
The aim of this study was to evaluate the differences in carcase traits, meat quality and muscle characteristics (mean fibre diameter and MyHCs levels of expression) between Mashen and Large White pigs. A total of 60 pigs (30 Mashen pigs and 30 Large White pigs, half male and half female in each breed) were used in this experiment. Results showed that Mashen pigs exhibited lower slaughter weight, reduced back-fat thickness, reduced loin eye area and lower lean meat ratio than Large White pigs \((p < .05)\). Meat from Large White pigs had higher pH1, greater drip losses, higher Warner-Bratzler shear force values, higher lightness, higher yellowness, and greater mean diameter of muscle fibres. Also, meat from Large white pigs had lower cooked yield, lower redness, and reduced intramuscular fat content than meat from Mashen pigs \((p < .05)\). The contents of 17 amino acids, total amino acids, essential amino acids and umami amino acids in the longissimus dorsi of Mashen pigs were higher than those in Large White pigs \((p < .05)\). Large White pigs had higher monounsaturated fatty acids and lower polyunsaturated fatty acids than Mashen pigs \((p < .05)\). Meanwhile, the expression of MyHCI was significantly higher and the expression of MyHCIlb was lower in Mashen than in Large White pigs \((p < .05)\). The higher MyHCI and lower MyHCIlb found in muscles from Mashen pigs might partially explain meat quality differences found between the two breeds in the present study. These results provide valuable information for meat quality differences between Mashen and Large White pigs.

HIGHLIGHTS
- Carcase traits and meat quality between Large White and Mashen pigs exhibited significant differences.
- The total amino acids, essential amino acids and umami amino acids in Mashen pigs were higher than those in Large White pigs.
- Large White pigs had higher monounsaturated fatty acids and lower polyunsaturated fatty acids than Mashen pigs.
- The expression of MyHCI was significantly higher and the expression of MyHCIlb was lower in Mashen than in Large White pigs.

Introduction
Meat quality is a very important issue for consumers and it is also vital for the meat industry (Şirin et al. 2017). With the continuous improvement of living standards, the demand of consumers for high quality meat is constantly increasing. Consumers’ requirements for meat include to be delicious, nutritious, safe and healthy (Joo et al. 2013). There are many factors influencing meat quality such as breed, genotype, sex, age, nutrition and slaughter conditions. Skeletal muscle fibre composition is one of the important factors influencing meat quality (Gil et al. 2003; Klosowska and Fiedler 2003; Choi et al. 2007). Myosin heavy chain (MyHC) is transcriptionally regulated in
pigs, which was more precise and reliable than traditional methodologies (Gunawan et al. 2007; Choi and Kim 2009; Park et al. 2009). Four MyHC isoforms were found to be expressed in the skeletal muscle of adult pigs: type I, IIA, IIX, IIB: type I, IIA, IIX, IIB (Lefaucheur et al. 2002). MyHC defines the contractile nature of fibre types: MyHC type I is the slower contractile type, followed by types IIA, IIX and IIB in increasing contractile speed order. Those contractile fibre types are usually associated with different metabolic activities. Type I fibres have greater oxidative capacity to support sustained contraction, whereas type IIB fibres are predominantly glycolytic and rapidly use glycogen for short bursts of activity. The Ila and IIX fibres are intermediate to type I and IIB fibres (Chang et al. 2003). Muscle fibre type composition has different effects on post-mortem change of meat quality. (Ozawa et al. 2000; Ryu et al. 2005), and abundance of MyHC IIB fibres is associated with less favourable meat quality, both in terms of pH, drip loss, grain, colour, yield force and work done (Chang et al. 2003). Meanwhile, the presence of type I fibre was positively related to good meat quality (Wimmers et al. 2008). An increase in the proportion of muscle fibre type I led to a decrease of lightness and an improvement of water-holding capacity in pork (Gil et al. 2003; Ryu and Kim 2005; Choi et al. 2010) and with improved tenderness and juiciness in beef (Maltin et al. 1998). Previous studies have found that type IIB fibres were closely related to toughness, paleness, higher protein denaturation and lower water-holding capacity in porcine longissimus muscle (Karlsson et al. 1993; Larzul et al. 1997; Kauffman et al. 1998; Renand et al. 2001; Ryu et al. 2008; Choi et al. 2010).

The Mashen pig, one of the most important indigenous breeds in northern China, exhibits high adaptability, good meat quality, slow growth rate and low feed conversion ratio. On the other hand, the Large White pig is a common breed for its high growth rate, feed conversion ratio and lean meat percentage (Zhang et al. 2001; Yang et al. 2005; Zhao et al. 2015). Therefore, these two pig breeds can serve as an ideal comparison for studying meat quality. Up to now, little was known about muscle fibre composition and post-mortem muscle metabolism in Mashen pigs, nor the breed differences between Mashen and Large White pigs. In the present study, the differences in muscle fibre composition, carcass traits and meat quality between Mashen and Large White pigs were compared. The aim of this study was to evaluate the differences in carcass traits, meat quality and muscle characteristics (IMFC, mean fibre diameter and MyHCs levels of expression) between Mashen and Large White pigs.

**Materials and methods**

**Animals**

Mashen pigs (n = 30; castrated males, n = 15; females, n = 15; 72.5 ± 0.6 kg) and Large White pigs (n = 30; castrated males, n = 15; females, n = 15; 119.5 ± 1.0 kg) under the same feeding management conditions (The composition of diets were shown in Table S1) were selected at 180-days old from the Datong Pig Farm (Shanxi, China). The selected pigs all were weaned at 28-days old and males were castrated when weaning. Among them, eight Mashen pigs (4 castrated males and 4 females, 72.8 ± 0.6 kg) and eight Large White pigs (4 castrated males and 4 females, 119.9 ± 1.0 kg) were selected randomly to determinate the amino acids composition, fatty acids composition and levels of MyHCs relative expression. Carcass traits and other meat quality measurements were conducted in all thirty pigs per breed. All of the animal procedures were conducted per the Code of Ethics of the World Medical Association (Declaration of Helsinki) for animal experiments (http://ec.europa.eu/environment/chemicals/lab_animals/legislation_en.htm). The methods were performed in accordance with the Good Experimental Practices adopted by the College of Animal Science and Veterinary Medicine, Shanxi Agricultural University (Shanxi, China). Moreover, the local animal welfare laws, guidelines, and policies were strictly followed for the feed and use of experimental animals. The experiment was approved by the Animal Ethics Committee of Shanxi Agricultural University.

**Carcass traits**

Electric shock was used to stun pigs, which then were exsanguinated. After removing hair, head, hooves and internal organs, the carcasses were weighed, and the carcass yields were calculated. In addition, the carcass length was measured from the midpoint of the anterior margin of the pubic symphysis to the midpoint of the anterior margin of the first cervical vertebra. The carcase bone, meat, skin and fat of the left side of carcases were separated and weighed to calculate lean meat ratio. The loin eye area was measured at the last rib level and calculated based on the loin eye height.
and width with 0.7 as the coefficient (Dai et al. 2009). The fat thickness of the first and last ribs, and the last lumbar vertebra were measured using a vernier calliper (Jiang et al. 2012). The average of those three measurements was used as the back-fat thickness.

**Meat quality**

Muscle pH (pH1) was measured at 45 min post-mortem in the longissimus dorsi (between the 13th and 14th rib) using pear-type portable pH metre (IQ-150 pH metre and PH77-SS probe, IQ Scientific Instruments, USA).

The longissimus dorsi samples at 10th to 11th thoracic were taken within 1–2 h after death and pieced to 4 cm × 4 cm × 4 cm size and weighted. Then the meat cubes were placed in inflated plastic bags and hung for 48 h at 4 °C (Honikel 1998). After that, meat cubes were reweighed. The drip loss is the percentage of two weight changes.

Approximately 80–100 g psosas major sample was taken at 24 h post-mortem. About 2 mg of extracted lipid was dissolved in 2 mL of n-hexane and 1 mL of KOH (0.4 M) for saponification and methylation. The fatty acid methyl esters were analysed with a gas chromatograph (ThermoFisher Trace 1310 ISQ, Thermo Corporation, USA) equipped with a capillary column (30 m × 0.25 mm × 0.25 μm film thickness). Nitrogen was used as carrier gas, the oven temperature was initially held at 80 °C. The temperature was rose at a rate of 10 °C min−1 to 200 °C and then continue got up to 250 °C (5 °C min−1). With the rate of 2 °C min−1, the temperature finally was up to 270 °C. The ion source and transmission line temperatures were maintained at 280 °C. Each fatty acid was identified by comparing their retention times with those of authenticated standards and quantified as a percentage of total fatty acids.

Approximately 100 mg samples of longissimus dorsi tissue at the 3rd to 4th lumbar vertebrae were dissolved in a solution of water and methanol (1:1) at 4 °C for 10 min and centrifuged at 10,000 × g for 10 min. The supernatant was filtered through glass wool. The 500 μL of the supernatant was used for amino acids analysis using liquid chromatograph (ThermoFisher U3000, Thermo Corporation, USA). Chromatographic conditions: flow rate, 1.0 mL per minute; column temperature, 40 °C; wavelength, 254 nm.

**Muscle characteristics**

Within 45 min post-mortem, longissimus dorsi samples at the last rib were taken for histochemical analysis. Muscle samples at a size of 0.5 cm × 0.5 cm × 0.2 cm were obtained and immediately put into 4% paraformaldehyde solution for paraffin embedding, which were then cross-sectioned for HE staining. The microscopic images were captured at 100 times magnification (OLYMPUS microscope, Olympus Corporation, Japan). Muscle fibre diameters were measured on ~100 fibres based on the smallest diameter. The diameter value was expressed as the mean value from all measurements. In addition, muscle fibre density was calculated by dividing the average number of muscle fibres in 10 randomly selected views by the view area (0.59 mm²), which was converted to the number of muscle fibre roots per mm².

The longissimus dorsi muscles between the 11th and 12th rib of Mashen pigs and Large White pigs were taken shortly after exsanguination, immediately.
snapped in liquid nitrogen, and stored at −80 °C for subsequent use. Quantitative real-time polymerase chain reaction (qPCR) was used to detect the mRNA expression patterns of MyHC, MyHCIIa, MyHCIIx and MyHCIIb. The primers of MyHCs used in present research referred to the study of Hu et al (Hu et al. 2008). 18S rRNA was used as the internal control. Details of primers are shown in Table 1. qPCR was performed using a SYBR® PrimeScript™II RT-PCR Kit (Takara, China) in conjunction with an ABI-7500 real-time PCR system (Applied Biosystems, USA). The reaction conditions were as follows: predenaturation at 95 °C for 30 s; 45 cycles of 95 °C for 30 s and 60 °C for 34 s; and one cycle of 95 °C for 30 s, 60 °C for 1 min, 95 °C for 30 s. To ensure robustness, each sample was analysed in triplicate. The relative expressions were quantified using the 2^−ΔΔCt method.

Statistical methods

Carcase traits, meat quality and muscle characteristics between Mashen and Large White pigs were analysed by one-way ANOVA in SPSS22.0 software. p < .05 indicates the difference is significant. Data were expressed as “means ± standard error of means (SEM)”. We are preprocessing the test data to analyse the effects of breed and sex. By building model found that gender had no significant influence on carcase traits and meat quality and muscle characteristics.

Results

Carcase traits of Mashen and large white pigs

The carcase traits in Mashen and Large White pigs are shown in Table 2. Compared with Large White pigs, the slaughter weight of the Mashen pigs were lower. When slaughtered at 180 days of age, the weight of the Mashen pigs were 72.5 kg, while that of Large White pigs were 119.5 kg. Mashen pigs had significantly lower back fat thickness, loin eye area and lean meat yield compared to Large White pigs (30.0 vs. 33.7, 25.6 vs. 51.6, and 48.8% vs. 63.5%, respectively, p < .05).

Meat quality characteristics of Mashen and Large White pigs

As shown in Table 3, meat quality characteristics between two breeds were significantly different (p < .05). Compared with Large White pigs, Mashen pigs had lower pH1, drip loss, WBSF, lightness, yellowness and higher cooked yield, redness and IMF. The content of amino acids (except lysine) in Mashen pigs was significantly higher than that in Large White pigs (Table 4) (p < .05). In addition, the sum of amino acids, umami amino acid and essential amino acids of Mashen pigs were significantly higher than those of Large White pigs (Table 4) (p < .05). Among

| Table 2. Carcase traits in Mahen pigs and Large White pigs (n = 30). |

| Breeds          | Traits          | Mashen | Large White | SEM | p value |
|-----------------|-----------------|--------|-------------|-----|---------|
| Live weight (kg) | 72.5            | 119.5  | 1.2         |     | <.001   |
| Carcase weight (kg) | 49.3            | 86.0   | 0.8         |     | <.001   |
| Carcase percentage (%) | 68.3            | 72.5   | 0.8         |     | <.001   |
| Carcase length (cm) | 77.1            | 102.1  | 1.1         |     | <.001   |
| Back-fat thickness (mm) | 30.0            | 33.7   | 0.4         |     | <.001   |
| Loin eye area (cm²) | 25.6            | 51.6   | 0.4         |     | <.001   |
| Lean meat rate (%) | 48.8            | 63.5   | 0.6         |     | <.001   |

Notes: The results were expressed as means. SEM: standard error of means.

| Table 3. Meat quality characteristics in Mashen and Large White pigs (n = 30). |

| Breeds          | Characteristics          | Mashen | Large White | SEM | p value |
|-----------------|-------------------------|--------|-------------|-----|---------|
| pH1             | 6.30                    | 6.45   | 0.05        |     | .004    |
| Drip loss (%)   | 2.86                    | 2.92   | 0.03        |     | .038    |
| Cooked meat percentage (%) | 65.20            | 58.40  | 0.79        |     | <.001   |
| WBSF (pound)    | 3.10                    | 5.63   | 0.05        |     | <.001   |
| Lightness       | 37.83                   | 38.60  | 0.38        |     | .044    |
| Redness         | 3.19                    | 2.85   | 0.04        |     | <.001   |
| Yellowness      | 0.92                    | 1.09   | 0.01        |     | <.001   |
| IMF (%)         | 3.73                    | 2.51   | 0.04        |     | <.001   |

Notes: The results were expressed as means. SEM: standard error of means.
The mRNA level of MyHCl was the lowest and MyHClb was the highest between the 4 MyHC isoforms compared within each pig breed. The mRNA expression of MyHCl and MyHClα in Mashen pigs was higher than that in Large White pigs (p < .05). On the other hand, the expression of MyHClb in Large White pigs was higher than that in Mashen pigs (p < .05). Regarding MyHClx mRNA levels of expression, no significant differences were observed between the two studied breeds (p > .05).

**Discussion**

In the present study, the muscle fibre diameters of Mashen pigs were smaller than Large White pigs, which might partially explain the lower drip loss, WBSF and higher cooked yield in Mashen pork. Previous studies suggested that muscle fibre diameter influences meat quality, and pork with greater muscle fibre diameters have higher levels of shear force, drip loss, cooking loss (Seideman and Crouse 2009; Rehfeldt et al. 2000; Bulotiene and Jukna 2008). We found that the IMF of Mashen pigs was 3.73% and Large White pigs was 2.51%. Consistently, it has been reported that the IMF of European pigs is 2% to 3%, while in Chinese indigenous pigs, the IMF is around 4% or even higher (Liu et al. 2016; Yang et al. 2016). In addition, Mashen pigs exhibited reduced loin eye area, reduced lean meat rate, lower drip loss, lower WBSF, and lower lightness values than Large White pigs. This is consistent with other studies evaluating meat quality of Chinese indigenous pig (Young 1995; Miao et al. 2009; Guo et al. 2011; Jiang et al. 2011; Wu et al. 2013; Liu et al. 2015). Because of genetic selection, the Large White pigs have higher growth rate and lean ratio when compared to less selected native pig breeds (Mashen pig). Consistently, Korean native pigs exhibited a higher IMF content and backfat thickness than European meat breeds (Kim et al. 2007). The Lantang pig is native to the southern part of China, which had a higher IMF content and back-fat thickness than the commercial European pig Landrace, while the Landrace exhibited a higher loin eye area and ash content than Lantang pig (Dai et al. 2009). The Min

### Table 4. Composition and content of amino acids in *longissimus dorsi* of Mashen and Large White pigs (g/100 g muscle) (n = 8).

| Amino acids          | Mashen | Large White | SEM  | p Value |
|----------------------|--------|-------------|------|---------|
| Aspartic acid (Asp)  | 2.27   | 1.86        | 0.05 | <.001   |
| Threonine (Thr)      | 1.04   | 0.84        | 0.02 | <.001   |
| Serine (Ser)         | 0.93   | 0.73        | 0.09 | .044    |
| Glutamic acid (Glu)  | 4.40   | 3.75        | 0.10 | <.001   |
| Proline (Pro)        | 1.36   | 0.89        | 0.02 | <.001   |
| Glycine (Gly)        | 1.68   | 0.94        | 0.04 | <.001   |
| Alanine (Ala)        | 1.84   | 1.42        | 0.04 | <.001   |
| Cystine (Cys)        | 0.25   | 0.19        | 0.05 | <.001   |
| Valine (Val)         | 1.39   | 1.17        | 0.03 | <.001   |
| Methionine (Met)     | 0.07   | 0.04        | 0.001| <.001   |
| Isoleucine (Ile)     | 1.28   | 1.12        | 0.02 | <.001   |
| Leucine (Leu)        | 2.36   | 1.95        | 0.05 | <.001   |
| Tyrosine (Tyr)       | 0.05   | 0.04        | 0.001| <.001   |
| Phenylalanine (Phe)  | 1.20   | 1.13        | 0.02 | .0074   |
| Lysine (Lys)         | 2.17   | 2.11        | 0.04 | .20     |
| Histidine (His)      | 0.55   | 0.41        | 0.01 | <.001   |
| Arginine (Arg)       | 1.70   | 1.26        | 0.04 | <.001   |
| Sum of amino acids   | 25.00  | 20.10       | 0.53 | <.001   |
| Essential amino acid | 10.06  | 8.77        | 0.21 | <.001   |
| Umami amino acid     | 11.49  | 8.86        | 0.23 | <.001   |

Notes: The results were expressed as means. SEM: standard error of means.

### Table 5. Composition and content of fatty acids in *longissimus dorsi* of Mashen and Large White pigs (% of total fatty acids) (n = 8).

| Fatty acids           | Mashen | Large White | SEM  | p Value |
|-----------------------|--------|-------------|------|---------|
| Palmitic acid (C16:0) | 27.2   | 27.4        | 0.59 | .74     |
| Palmitoleic acid (C16:1)| 4.5   | 4.1         | 0.08 | <.001   |
| Stearic acid (C18:0)  | 11.1   | 12.0        | 0.26 | .0036   |
| Oleic acid (C18:1)    | 44.8   | 48.2        | 1.11 | .0082   |
| Linoleic acid (C18:2) | 11.0   | 7.5         | 0.21 | <.001   |
| Linolenic acid (C18:3) | 0.5  | 0.1         | 0.005| <.001   |
| Arachidic acid (C20:0)| 0.2    | 0.1         | 0.002| <.001   |
| Arachidonic acid (C20:1)| 0.7  | 0.6         | 0.014| <.001   |
| Saturated fatty acid  | 38.5   | 39.5        | 1.08 | .37     |
| Unsaturated fatty acid| 61.5   | 60.5        | 1.42 | .051    |
| Monounsaturated fatty acid | 50.0 | 52.9        | 1.24 | .034    |
| Polyunsaturated fatty acid | 11.5 | 7.6         | 0.23 | <.001   |

Notes: The results were expressed as means. SEM: standard error of means.

amino acids, the content of Glutamic acid (Glu) was the highest (Mashen pig, 4.40 g/100g; Large White pig, 3.75 g/100g) (Table 4) (p < .05).

As shown in Table 5, the content of monounsaturated fatty acids in Mashen pigs was significantly lower than that in Large White pigs. On the contrary, polyunsaturated fatty acids were more abundant in Mashen pigs (p < .05).

**Muscle characteristics of Mashen and Large White pigs**

As shown in Table 6, compared with Large White pigs, Mashen pigs had lower diameter and higher density of muscle fibres.

### Table 6. Diameter and density of muscle fibres (*longissimus dorsi*) in Mashen and Large White pigs (n = 30).

| Characteristics          | Mashen | Large White | SEM  | p Value |
|--------------------------|--------|-------------|------|---------|
| Diameter of muscle fibres/μm | 55.43 | 71.90       | 0.76 | <.001   |
| Density of muscle fibres/roots × mm² | 221.31| 160.28   | 2.33 | <.001   |

Notes: The results were expressed as means. SEM: standard error of means.
pig (such as Heilongjiang Province), a well-known Chinese fat-type breed, is famous for its high IMF, superior meat quality, and stress resistance. Compared with Min pig, the Large White pig has a faster growth rate and higher lean meat ratio (Liu et al. 2017).

Muscle fibre types were related to meat quality and carcass traits in various species, including cattle (Ozawa et al. 2000; Picard et al. 2006; Hwang et al. 2010), pigs (Larzul et al. 1997; Ryu and Kim 2006) and poultry (Dransfield and Sosnicki 1999; Kim et al. 2008). In adult pigs, skeletal muscles consist of four contractile fibre types (Type I, Ila, IIX, IIb), which are characterised by the expression of MyHC gene isoforms (Lefaucheur et al. 2002). The expression of MyHC genes was highly correlated with the relative amount of the corresponding protein and is used to classify the muscle fibre type composition (Gunawan et al. 2007). The positive correlation between MyHC mRNA expression and its corresponding protein level has also been shown by others (Cox and Buckingham 1992; Schiaffino and Reggiani 1996; Mckoy et al. 1998). Therefore, MyHCs gene expression was used to define muscle fibre type composition, which was more precise and reliable than traditional methodologies (Gunawan et al. 2007; Choi and Kim 2009; Park et al. 2009).

In the present study, both Mashen and Large White pigs, showed higher levels of expression of MyHCIIb than that of MyHCI. This is consistent with previous studies which generally show that the longissimus muscle of pigs has higher proportions of type IIb than type I fibres (Marita and Eero 2004; Ryu et al. 2008; Lee et al. 2012). The proportions of type IIb fibres were 69.7-90.3% in pig longissimus dorsi from various breeds, such as Berkshire, Yorkshire, Landrace, Duroc and their crossbred pigs (Marita and Eero 2004; Ryu et al. 2008; Lee et al. 2012). Importantly, the expression of MyHCI was higher in Mashen than in Large White pigs, whereas the expression of MyHCIIb was higher in Large White pigs. Each muscle fibre type has different biochemical and biophysical characteristics. The differentially expressed muscle fibre types may be the most important factors influencing meat quality, particularly IMF content and drip loss (Ozawa et al. 2000; Ryu et al. 2005; Kim et al. 2008; Guo et al. 2011). Type I fibres contain neutral lipids, whereas only 26% and 1% of types Ila and IIb fibres contain lipids (Karlsson et al. 1999). The type I fibres contain abundant mitochondria and greater amount of intramyofibrilar lipid content (Lefaucheur et al. 2002), while pig muscle with a higher proportion of fast-twitch fibres had a lower intramuscular lipid content (Fiedler et al. 2003). Hence, the higher IMF in Mashen pigs than Large White pigs might be partially due to a higher proportion of type I and a lower proportion of type IIb in Mashen pigs. In addition, drip loss is influenced by the characteristics of muscle fibres, especially type IIb (Larzul et al. 1997; Ryu and Kim 2006). Meat from Large White pigs had a higher drip losses and lower pH, which might be due to a higher proportion of type IIb fibres. Type IIb fibres are predominantly glycolytic, which contribute to the rapid metabolism of glycogen during the early post-mortem period, producing higher amounts of intramuscular lactate and faster pH decline rates, resulting in poorer meat quality (Schiaffino and Reggiani 1996; Pette and Staron 2001; Choi and Kim 2009). Consistently, meat with a higher percentage of type IIb fibres and lower percentage of type I fibres showed lower pH, paler colour, and higher drip loss (Ryu and Kim 2006; Choi et al. 2007; Choe et al. 2008; Choi et al. 2010). With the higher expression level of MyHCI and lower expression level of MyHCIIb, Mashen pigs had a higher redness and lower lightness, and lower WBSF. In agreement, tenderness is affected by fibre type, especially type IIb fibres. Muscles with larger type IIb fibres may be tougher or may have greater hardness (Karlsson et al. 1993; Zochowska et al. 2005). In addition, due to the presence of abundant mitochondria and myoglobin in type I fibres, higher percent of type I fibres were related to lower lightness and higher redness (Ryu and Kim 2006; Hwang et al. 2010; Kim et al. 2013).

The soluble amino acid content correlates with the flavour of meat (Yang et al. 1994; Shi et al. 2003; Chen et al. 2006).
et al. 2004; Zhu et al. 2008). Six umami amino acids (Gly, Ile, Pro, Ser, Ala and Glu) are directly related to the flavour, of which Glu is the most important umami amino acid, (Hood and Allen 1973). Comparing the amino acid composition of Bamei, Landrace and their hybrid pigs, 17 amino acids were significantly different among these breeds, of which Bamei pigs had the highest content of umami amino acids (such as Glu) (Yang et al. 1994). In this study, the contents of Glu, Gly, Ile, Pro, Ser and Ala, were higher in Mashen pigs than that in Large White pigs, which may cause the Mashen pig has the better taste of pork.

In present study, the monounsaturated fatty acids content was lower in Mashen pigs than in Large White pigs, while the content of polyunsaturated fatty acids was higher in Mashen pigs. The content of saturated fatty acids is also related to muscle quality (Hood and Allen 1973; Cameron and Enser 1991). Unsaturated fatty acids are not only an important precursor to meat flavour, but also an indispensable nutrient for human body (Hallenstvedt et al. 2012). On the other hand, saturated fatty acids can cause atherosclerosis, elevated blood lipids, thrombotic disorders and other issues, while increased unsaturated fatty acids (n-3 polyunsaturated fatty acids) uptake can decrease blood cholesterol level and prevent atherosclerosis (Bhavsar and Stonge 2016). In addition, a higher content of C18:3 was found in Mashen pork than Large White pork. Polyunsaturated fatty acids, especially the n-3 fatty acids, are beneficial to human health (Weber and O’Neill 2008; Wood et al. 2008). Therefore, Mashen pig meat products may have more nutritional value and may be more beneficial to human health.

Conclusions
The Mashen pigs had lower drip loss, WBSF, lightness, yellowness, pH, diameter of muscle fibres and higher cooked yield, redness, IMF than Large White pigs. The content of MyHCl was higher and MyHClb was lower in Mashen pigs, which might relate to their meat quality. These data provide valuable information for meat quality difference of Mashen and Large White pigs.

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Disclosure statement
We confirm that this manuscript has not been published in whole or in part and is not being considered for publication elsewhere. The authors declare that there is no conflict of interests.

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