



Carcass composition and meat quality of indigenous Yanan pigs of China

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ABSTRACT. The Yanan (YN) pig is a traditional Chinese indigenous breed that is raised in southwest China in the Sichuan Province, but there is little data on the germplasm characteristics of this breed. To evaluate carcass characteristics and meat quality of the YN pig, we compared carcass and meat quality of YN pigs and Landrace × Yanan (CY) hybrid pigs; 30 YN pigs and 30 CY pigs weighing 20 ± 2 kg were reared and slaughtered at the normal slaughter weight (100-120 kg). The carcasses were chilled and the left carcass side was dissected into bone, lean meat, fat, and skin; meat quality parameters were measured. Carcasses of YN pigs were lighter (88.85 vs 90.05 kg, $P < 0.05$) and shorter (71.88 vs 77.61 cm, $P < 0.001$); they contained less lean meat (41.60 vs 49.25%, $P < 0.001$), less ham and breech (25.93 vs 27.53%, $P < 0.001$) and less carcass bone (9.83 vs 10.53%, $P < 0.01$) than did carcasses of CY pigs. On the other hand, YN pigs had more carcass subcutaneous fat and skin (48.58 vs 40.23%, $P < 0.001$), thicker backfat (3.67 vs 3.43 cm, $P < 0.001$) and smaller loin muscle area (9.83 vs 26.91 cm², $P < 0.001$) compared with CY pigs. Among meat quality parameters, YN pigs had higher pH₁ (6.41 vs 6.17, $P < 0.001$), higher color score_u (3.86 vs 3.36, $P < 0.001$) and lower Minolta L_u values (40.89 vs 45.32, $P < 0.01$)

than CY pigs. On the other hand, YN pigs had lower drip loss (1.31 vs 2.26%, $P < 0.05$) and lesser fiber area (2351.34 vs 3025.43 μm^2 , $P < 0.01$) than CY pigs. Both breeds had high intramuscular fat (4.46% in YN and 4.45% in CY). No significant differences in other carcass traits and meat quality were found in the two populations. We conclude that YN pigs could be used in commercial pig production to provide good tasting and high-quality niche products.

Key words: Chinese indigenous pig breed; Yanan breed; Meat quality; Landrace \times Yanan; Carcass composition

INTRODUCTION

The Chinese swine industry is by far the largest of any country in the world. The 2009 standing population was reported to be 463 million head and the slaughter at 668 million (Jiang and Li, 2010). There are about 100 local swine breeds in existence in China and the native pig breeds have high reproductive rates, fine meat quality, good adaptability for extensive feeding and management, and the ability for high utilization of green-crude. However, because of undesirable traits such as slow growth rate, low dress and lean meat percentage, few local breeds are utilized on large commercial farms (Jones, 1998). One of the reasons for the increasing interest in local pig breeds is the better quality of meat compared to modern breeds (Lan et al., 1993; Dunn, 1996; Labroue et al., 2000; Cesar et al., 2010).

Yanan (YN) pig is a traditional commercial pig breed and is raised in Southwest China in Sichuan Province. Due to the poor growth performance and carcass composition, the YN pig is in danger of extinction. Today, the YN pig is included in the national preservation program for autochthonous breeds. The YN pig is adapted to poor breeding conditions and is reputedly a good cultivating breed. However, there were few reports about the germplasm characteristics of the breed. Therefore, the present study was aimed at the first evaluation of carcass characteristics and meat quality in the Chinese local pig breed YN in comparison with hybrid pigs of Landrace \times Yanan (CY) in order to protect and utilize this precious genetic resource.

MATERIAL AND METHODS

The trial was conducted in compliance with the requirements of the Animal Ethics Committee of Sichuan Agricultural University.

Animals and management

The experiment was organized by Sichuan Agricultural University and conducted on the farm of Sichuan Agricultural University. A total of 60 castrated male pigs ($N = 30$ per population) were randomly selected with the similar weight (20 kg). All pigs were housed in individual pens (2 m^2) located in the same room. All pigs were fed twice every day with the same diet, and pigs had *ad libitum* access to diet and water (nipple drinkers) after a 7-day adaptation period. The experimental diets were based on corn and soybean meal, and were formulated with crude protein concentrations, trace minerals and vitamins for the different growth phases. During the period

from 20 to 50 kg, the pigs were fed a diet containing 14.0 MJ/kg metabolizable energy and 18% crude protein (9.0 g/kg lysine); from 50 kg to slaughter weight, they received a diet containing 13.5 MJ/kg metabolizable energy and 16.0% crude protein (8.0 g/kg lysine).

Carcass measurements

At their predesignated slaughter weight (live weight: 120 kg), all pigs were slaughtered to determine carcass composition according to the methods described by Xiao et al. (1999). Briefly, all pigs were transported to an abattoir. The pigs received no feed on the day of slaughter, but were allowed to rest for 2 h after about 1 h of transportation (including loading and unloading), after which they were electrically stunned (90 V, 10 s and 50 Hz), exsanguinated, dehaired, and eviscerated. The head was removed and the carcass was split longitudinally. Carcass length was taken as a distance from atlas to os pubis. Longissimus dorsi area was determined by tracing its surface area at the 10th rib and by using a planimeter (Planix 5.6, Tamaya Digital Planimeter, Tamaya Tecnic Inc., Tokyo, Japan). The average of three backfat thickness measurements was taken on the first rib, last rib and last lumbar along the midline with a sliding caliper. Ham and hip were cut from the left carcass, and bone, muscle, subcutaneous fat, and skin were physically dissected, while each of the dissected tissues was weighed to the nearest gram. Carcass dressing percentage was determined from the live weight (after fasting overnight but with free access to drinking water and weighed at the farm) and the hot carcass weight.

Meat quality measurements

The longissimus dorsi of the left side carcass at the last third/fourth rib was sampled and used to measure meat quality. pH was measured using pH star (Osaka, Japan) at 45 min and 24 h post-mortem. The electrode was calibrated with pH 4.6 and 7.0 buffers and equilibrated at 20°C for the measurements on the warm carcass 45 min post-mortem and equilibrated at 4°C for the measurements at 24 h post-mortem. Color parameters were determined using a Minolta CR-300 colorimeter (Minolta Camera, Osaka, Japan) with an illuminant D65, a 10° standard observer and a 2.5-cm port/viewing area. The measurements were repeated at five randomly selected places on each slice and averaged. Subjective marbling scores (National Pork Producers Council, 2000) were evaluated at approximately 24 h post-mortem. Subjective color scores (National Pork Producers Council, 2000) were evaluated at approximately 45 min and 24 h post-mortem. Drip loss was defined as the weight loss of a meat sample (50 g), placed on a flat plastic grid and wrapped in foil, after a storage time of 24 h in a refrigerator (4°C). Cooking loss packaged under vacuum was maintained in a circulating water bath at 75°C. The analysis of intramuscular fat (IMF) content of the longissimus dorsi was according to the Association of Official Analytical Chemists (1990) procedures. Muscle fiber area was determined using the procedure described by Ginte and Vigilijus (2008).

Statistical analyses

All data were statistically analyzed by the general linear model and means procedure of Statistical Product, version 8.0 (SAS Institute Inc., Cary, NC, USA). The model included the pig population as main effects. The Duncan test was applied to compare the mean values

of the pig population. Mean values, standard deviation, coefficient of variation, minimum and maximum are reported in Tables. Differences were considered to be significant at $P \leq 0.05$.

RESULTS AND DISCUSSION

Carcass composition

Carcass characteristics in the two pig populations are shown in Table 1 and there are big differences between the two populations. Carcasses of the YN pigs were lighter ($P < 0.05$) and shorter ($P < 0.001$); however, they contained less lean meat ($P < 0.001$), less ham and hip ($P < 0.001$) and less carcass bone ($P < 0.01$) than did carcasses of the CY pigs. On the contrary, the YN pigs had more carcass subcutaneous fat and skin compared with the CY pigs ($P < 0.001$). In addition, the YN pigs had thicker backfat and smaller loin muscle area compared with the CY pigs ($P < 0.001$). No significant difference in dressing percentage was attributable to the two populations. These above results indicate that the YN pig has strong ability to deposit lipids showing high subcutaneous fat percentage and low lean meat percentage as well as another Chinese native breeds; by contrast, the CY pig, which has a half proportion of Landrace, has high lean meat percentage as well as foreign breeds.

Table 1. Simple means, standard deviations (SD), coefficients of variation (CV%), ranges for carcass composition (Min, Max), differences between pig populations, and significance (P).

	YN (N = 30)					CY (N = 30)					P
	Mean	SD	CV%	Min	Max	Mean	SD	CV%	Min	Max	
Carcass weight (kg)	88.85	2.70	3.04	82.50	95.50	90.05	1.59	1.76	85.50	93.50	*
Carcass length (cm)	71.88	1.35	1.88	69.50	74.00	77.61	2.06	2.65	73.00	82.00	***
Dressing percentage (%)	72.54	2.02	2.78	67.50	77.56	72.76	4.66	6.41	60.87	78.25	ns
Backfat thickness (cm) ^A	3.67	0.39	10.48	3.05	4.46	3.34	11.05	2.54	4.07	0.37	***
Loin muscle area (cm ²)	9.83	0.58	5.90	8.54	10.75	26.91	3.07	11.40	21.38	32.50	***
Carcass lean (%)	41.60	3.00	7.21	35.26	47.03	49.25	2.94	4.66	43.80	53.82	***
Ham and breech (%)	25.93	0.97	3.72	23.89	27.92	27.53	1.03	3.74	25.44	30.55	***
Carcass fat and skin (%)	48.58	3.14	6.47	43.08	54.39	40.23	2.88	7.17	34.47	47.36	***
Carcass bone (%)	9.83	0.58	5.90	8.54	10.75	10.53	1.04	9.85	8.37	11.99	**

^AThe average of the first rib, last rib and last lumbar. YN = Yanan breed; CY = Landrace × Yanan. ns = not significantly different ($P > 0.05$). *Significant at the 5% level. **Significant at the 1% level. ***Significant at the 0.1% level.

The results are in accordance with previous reports (Xu, 1994; Miao et al., 2009), which expressed that the Jinhua pig is characterized by stronger fatty deposition and lower lean meat percentage compared with Landrace. Gispert et al. (2007) found that the Meishan pig has lighter carcass weight, higher subcutaneous fat percentage, lower lean meat percentage and bone percentage compared with some different genetic types of pig (Landrace, Large White, Duroc, Pietrain). Wagner et al. (1999) also found differences in the carcass composition from different genetic types of swine. The higher backfat thickness and lower carcass lean content in Chinese native pigs were related to their lower muscle growth potential. The greater ability of Chinese native pigs to deposit lipids is probably related to an indirect effect of concomitant breed difference in protein accretion and an increase of extra energy available for lipid synthesis (Renaudeau and Mourot, 2007). Similar results were reported when Meishan (White et al., 1993; Litten et al., 2004), Iberian (Morales et al., 2003) or Creole pigs (Renaudeau and Mourot, 2007) were compared with conventional lean pigs.

The crossbred CY pigs, crossing modern Landrace breed and local YN breed, had better carcass characteristics than the YN pigs. The results were in accordance with previous reports (Lan et al., 1993), which expressed that the pigs from Yorkshire × Meishan, Yorkshire × Fengjing, and Yorkshire × Minzhu were characterized by lower fatty deposition, higher lean meat percentage compared with purebreds of Meishan, Fengjing and Minzhu.

Meat quality parameters

Meat quality in the two pig populations is shown in Table 2. The YN pigs had higher pH₁ value than the CY pig ($P < 0.001$); however, no significant difference was found in pH_u value in the two populations. pH was of value for predicting technological as well as eating quality of pork (van Laack et al., 1994; van der Wal et al., 1995). Jones (1998) reported that reference was commonly made to three distinct pH-related abnormalities. These were namely the PSE (pale, soft, exudative) meat condition (associated with pH₁ values lower than 5.9-6.1 depending on the muscle), the DFD (dark, firm, dry) meat condition (associated with pH_u values higher than 6.0-6.2) and the “acid meat” condition (associated with pH_u values lower than 5.4-5.5). Interestingly, the pH₁ value of the YN pig (6.41) was rather high in the present study. Warriss et al. (1996) also reported higher muscle pH₁ for local breeds. On the contrary, Labroue et al. (2000) reported lower muscle pH₁ (longissimus dorsi) and higher muscle pH_u (semimembranosus) for local breeds in comparison with Yorkshire; however, no indication was given on the stress susceptibility gene status of their local breeds. In the two populations, the pH values were within normal scopes and the meat had no characteristics of PSE, DFD or “acid meat”.

Table 2. Simple means, standard deviations (SD), coefficients of variation (CV%), ranges for meat quality (Min, Max), differences between pig populations, and significance (P).

	YN (30)					CY (30)					P
	Mean	SD	CV%	Min	Max	Mean	SD	CV%	Min	Max	
pH ₁	6.41	0.18	2.86	6.05	6.75	6.17	0.28	4.48	5.50	6.58	***
pH _u	5.80	0.14	2.46	5.50	6.20	5.74	0.18	3.05	5.40	6.15	ns
Color score ₁ ^A	3.33	0.27	8.20	3.00	4.00	3.26	0.31	9.41	2.50	4.00	ns
Color score _u ^A	3.86	0.57	14.79	2.50	4.70	3.36	0.40	11.91	2.50	4.00	***
Minolta L ₁	39.85	2.58	9.69	36.68	45.96	41.13	2.49	13.56	38.63	49.69	ns
Minolta L _u	40.89	2.69	11.23	37.56	46.78	45.32	2.79	11.48	40.56	48.69	**
Marbling score ^A	2.90	0.48	16.57	2.00	4.00	2.83	0.54	19.06	2.00	4.00	ns
IMF (%)	4.46	1.65	36.87	1.84	9.17	4.45	1.08	26.54	2.79	7.70	ns
Drip loss (%)	1.31	0.56	42.61	0.46	3.79	2.26	1.57	69.32	0.71	7.86	*
Cooking loss (%)	29.09	4.51	15.51	17.83	33.96	28.89	3.22	11.14	17.72	33.52	ns
Fiber area (μm ²)	2351.34	757.79	25.38	1753.85	3256.78	3025.43	857.36	33.56	2345.69	4896.79	**

pH₁, color score₁, Minolta L₁ (at 45 min post-mortem); pH_u, color score_u, Minolta L_u (at 24 h post-mortem). ^ANational Pork Producers Council (NPPC) (2000). YN = Yanan breed; CY = Landrace × Yanan. ns = not significantly different ($P > 0.05$). *Significant at the 5% level. **Significant at the 1% level. ***Significant at the 0.1% level.

Higher color score_u and lower Minolta L_u values in longissimus dorsi were found for the YN pigs compared with the CY pigs ($P < 0.001$ and $P < 0.01$, respectively); however, no significant difference was found in color score₁ and Minolta L₁ in the two populations. Similar results were reported between Iberian and Landrace pigs (Serra et al., 1998) or between Creole pig and Large white (Renaudeau and Mouro, 2007). Ramirez et al. (2007) also found that the Minolta L value was influenced by the genotype of pigs. Miao et al. (2009) found the Jinhua pig meat had lower Minolta

L value and tended to be darker than that of Landrace. However, these results conflict with earlier studies (Edwards et al., 2003), which observed that objective Minolta L values were not different between breeds of pig (Duroc- and Pietrain-sired pigs). According to the meat color standards of the National Pork Producers Council (2000), a color score level of 3-4 and Minolta L value level of 43-49 are considered to be ideal. In the present study, the color score and Minolta L values were perfect in the populations, which indicated that the two pig populations had good meat color.

The YN pigs had lower drip loss than CY pigs ($P < 0.05$); however, no significant difference was found in cooking loss between the two populations. Very high pH levels in the YN pigs could result in high water holding capacity (WHC). Water is the major meat constituent representing approximately 75% of the meat weight, and is an essential quality parameter, both for industry and the final consumer. High WHC values might provide advantages in processed meats for the industry, and advantages in the fresh meat appearance for the consumer (den Hertog-Meischke et al., 1997). The main factors that affected WHC and thus drip loss were: genotype (HAL and RN genes), pre-slaughter management and stunning methods (Claeys et al., 2001; Schäfer et al., 2002). According to den Hertog-Meischke et al. (1997), other important features that affected WHC was the predominant type of fiber in the muscle. Muscles with mostly glycolytic fibers, also called white muscle fibers (fast contraction, type II A, anaerobic) had a lower WHC and a high pH drop rate after death (Lawrie, 2005), as well as a lower final pH.

IMF content is related to organoleptic characteristics of pig meat and influences meat and meat product quality (Wood et al., 1988), and IMF content depends on the genotype of pigs (Aftentranger et al., 1996). Generally, fat is an important holder of flavor. Consequently, IMF content seems to have a decisive influence on tenderness, juiciness and flavor of pig meat. Meat with a low fat content is insipid, strawy and dry. In the present study, the two populations had high marbling scores (2.90 in YN and 2.83 in CY) and had high IMF content (4.46% in YN and 4.45% in CY). From these results, one can assume that the two populations have a strong level of lipid synthesis activity. Similarly, an increase in lipogenic enzyme activities in adipose and muscle tissue was reported by Serra et al. (1998) and Morales et al. (2003) when Iberian pigs were compared with Landrace pigs. An IMF content of 2-3% was suggested to be optimal for eating quality (Bejerholm and Barton-Gade, 1986; DeVol et al., 1988). However, the average IMF content of pig meat has decreased below this optimum because of the selection for lean meat content. Therefore, strategies to improve IMF content are the new objective, especially in the commercial pig population. The high IMF content in the two pig populations can meet the demand for high taste quality niche products.

The YN pigs had a smaller fiber area than the CY pigs (2351.34 vs 3025.43 μm^2 , $P < 0.01$). The result was in accordance with previous results (Lan et al., 1993), which reported that Yorkshire pigs had a larger fiber area than Meishan (4206 vs 3213 μm^2 at approximately 100 kg live weight). These present results indicated the YN pigs and the CY pigs had small fiber area. Muscle fiber area was an important factor affecting numerous pre- and post-mortem biochemical processes and thus also meat quality (Klosowska and Fiedler, 2003). Pork muscle fiber area influences meat quality, and pork with high muscle fiber area has high shear force, drip loss and cooking loss (Ginte and Vigilijus, 2008). Small fiber area may help explain why YN had high water holding capacity.

CONCLUSION

Over all, the YN pigs had good meat quality but poor carcass composition. The CY

pigs not only retained the good meat quality characteristics of the YN pigs but also carcass composition was greatly improved. From our results, it can be suggested that YN pigs could be used in commercial pig production to provide high taste quality niche products.

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