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Original article

A comparison of carcass and meat quality characteristics of Creole and Large White pigs slaughtered at 150 days of age

David RENAUDEAU[a]*, Magali HILAIRE[a], Jacques MOUROT[b]

[a] INRA, Unité de Recherches Zootechniques, 97170 Petit Bourg, Guadeloupe, French West Indies, France
[b] INRA, Unité Mixte de Recherches sur le Veau et le Porc, 35590 St-Gilles, France

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Abstract – The effects of breed in combination with sex (female vs. castrated male) on carcass composition and meat quality characteristics were studied in a factorial arrangement of treatments involving 32 Large White (LW) and 32 Creole (CR) pigs. The pigs were slaughtered at 150 d of age; the slaughter weights were 90 and 60 kg for LW and CR pigs, respectively, which corresponded to the practical commercial slaughter weight in the French West Indies for both breeds. No interaction between breed and sex was found for all criteria studied. Creole pigs had a lower killing out percentage (82.9 vs. 80.9%, $P < 0.001$) and higher backfat thickness at 150 d of age (17.5 vs. 11.3 mm, $P < 0.001$) than the LW pigs. Higher pH 24 h post mortem were observed in the *semimembranosus (SM)*, *longissimus dorsi (LD)*, and *semispinalis (SS)* muscles of the CR than of the LW breeds ($P < 0.01$). The drip and cooking losses of meat measured in the LD muscle were lower in the CR than in the LW pigs (5.9 vs. 10.6% and 30.2 vs. 33.1%, respectively, $P < 0.10$). Creole pigs showed higher intramuscular fat percentage in LD muscle (3.45 vs. 2.46%, $P < 0.001$), more saturated (40.0 vs. 37.9%) and monounsaturated (40.6 vs. 38.4%) fatty acids and lower concentration of C18:2 and C18:3 in backfat than LW pigs (17.3 vs. 21.1% and 0.96 vs. 1.31%, respectively). Whatever the breed, the females (F) were leaner ($P < 0.05$) than the castrated males (C). The females showed higher drip and cooking losses in LD muscle and lower pH 24 h post mortem in LD and SM muscles. The saturated fatty acid concentrations were lower in F than in C. These results emphasise the reduced carcass performance of CR breed in intensive management and its superiority as far as the criteria of technological and sensory qualities of the fresh meat are concerned.

pig / breed / sex / Creole pigs / carcass / meat quality

Résumé – Comparaison des caractéristiques de la carcasse et de la qualité de la viande des porcs Créole et Large White abattus à 150 jours d'âge. Les effets du génotype combinés à ceux du sexe sur la composition de la carcasse et la qualité de la viande ont été étudiés selon un dispositif factoriel sur 32 porcs Large White (LW) et 32 porcs Créole (CR). Tous les porcs ont été abattus à 150 jours d'âge ; les poids d'abattage étaient de 90 et 60 kg respectivement pour les porcs Large White et les porcs Créole ce qui correspond aux poids d'abattage habituellement rencontrés aux Antilles pour

* Corresponding author: renaudea@antilles.inra.fr

ces deux génotypes. L'interaction entre le génotype et le sexe n'a été significative pour aucun des critères étudiés. Le rendement de la carcasse est inférieur (*P* < 0,001) et l'épaisseur de lard dorsale mesurée à 150 jours d'âge est plus élevée (*P* < 0,001) chez le porc CR comparé au LW (respectivement, 82,9 vs. 80,9 % et 17,5 vs. 11,3 mm). Des pH ultimes supérieurs ont été mesurés au niveau des muscles *semimembranosus (SM)*, *longissimus dorsi (LD)* et *semispinalis (SS)* chez le porc CR (*P* < 0,01). Les pertes d'eau au ressuyage et à la cuisson mesurées sur le muscle LD sont plus faibles (*P* < 0,10) chez le CR (respectivement, 5,9 vs. 10,6 % et 30.2 vs. 33.1 %). Les teneurs en lipides intramusculaire du LD (3,45 vs. 2,46 %) et en acides gras saturés (40,0 vs. 37,9 %) et monoinsaturés (40,6 vs. 38,4 %) de la bardière sont supérieurs (*P* < 0,01) chez le CR. En revanche, les teneurs en C18:2 et C18:3 sont significativement supérieures chez le LW (respectivement, 21,1 vs. 17,3 % et 1,31 vs. 0,96 %). Indépendamment du type génétique, les femelles (F) sont significativement plus maigres que les mâles castrés (C). Les pertes d'eau au ressuyage et à la cuisson du muscle LD sont plus élevées et le pH ultime mesuré au niveau du LD ou du SM est plus faible chez les mâles. La concentration en acides gras saturés dans la bardière est plus faible chez les F par rapport au C. Ces résultats confirment la réduction des performances de carcasse des porcs CR élevés dans des systèmes d'élevage intensifs et la supériorité du porc CR en ce qui concerne les critères de la qualité technologique et gustative de la viande fraîche.

porc / type génétique / porc Créole / carcasse / qualité de la viande

1. INTRODUCTION

The Creole pig (CR), the local pig breed from the Caribbean, constitutes a heterogeneous population resulting from successive crossings between Iberian stocks introduced into the West Indies as early as the 16th century and French, English, and American breeds introduced throughout the centuries. In Guadeloupe (F.W.I., 16° Lat. N., 61° Long. W.), the CR pig represents approximately 40% of the total pig population and it is often produced under extensive management in small herd size with feeding based on the use of local resources. Some studies have compared reproductive and growth performance of CR with conventional exotic breeds in semi-intensive conditions [7, 8, 15]. The CR pig is known for its hardiness and adaptation to a harsh environment and is characterised by an early sexual maturity, a low prolificacy, and reduced growth and carcass performances. Moreover, the excessive fat and very poor muscle development limits the use of CR pigs in a semi intensive production system whereas their meat is popular and particularly appreciated by the people of Guadeloupe. As other local French breeds [21], the absence of selection for muscle content in CR pigs may be associated with a high meat quality. From that point of view, very little has been published on the meat, fat, and eating quality of the CR pig. Despres et al. [11] demonstrated a better meat eating quality for CR pigs compared to LW pigs. They also showed the superiority of CR in terms of the technological quality of lean meat using pH measurements. As far as we know, the biochemical lean and fat composition of the CR meat has not yet been described.

The objective of this study was to evaluate the effect of pig breed (Creole vs. Large White) and sex (females vs. castrated males) on the growth performance, carcass performance, meat quality and histochemical characteristics of backfat at a constant slaughtered age.

2. MATERIALS AND METHODS

2.1. Experimental design

Two successive replicates of 16 females and 16 castrated males from Creole (CR) and Large White (LW) breeds were studied between 90 and 150 days of age. The experiment was designed so that both CR and LW pigs were to be slaughtered at their usual commercial slaughter weight in the French

Table I. Composition of the diet[a].

Chemical composition (%)	
Measured values	
Dry matter	84.2
Crude protein	15.4
Crude fat	3.2
Starch	33.2
Crude fibre	5.4
NDF	22.6
ADF	6.8
ADL	1.5
Calculated values[b]	
Lysine (%)	0.84
Methionine + cystine (%)	0.43
Threonine (%)	0.46
Tryptophan (%)	0.15
Net energy (MJ per kg)	9.00

[a] Formulated with corn, soybean meal, wheat middlings, and wheat bran;
[b] The amino acids content was calculated by additivity from characteristics of raw materials according to AMIPIG (2000). The net energy value was calculated from the chemical composition of the diet according to Noblet et al. [30].

West Indies (i.e., 60 and 90 kg live weight, respectively). This experiment was conducted at the experimental facilities of INRA Guadeloupe located in a humid tropical area (F.W.I., 16° Lat. N., 61° Long. W.). At 80 days of age, the pigs were allotted to four groups of eight animals according to breed and sex. For each breed, blocks of two littermates were constituted in order to study the effect of sex. The first 10 days were considered to be an adaptation period to the experimental conditions. The pigs were reared in an open-front building equipped with a pen (3 × 4 m) on a slatted concrete floor. They were fed ad libitum with a conventional diet based on corn, soybean meal, wheat middling, and wheat bran. The chemical composition of the diet is presented in Table I. The pigs had free access to water provided from low-pressure nipple drinkers. The ambient temperature and relative humidity were recorded continuously (1 measurement every 30 seconds) in the experimental building using a probe (Campbell Scientific Ltd., Shepshed, UK) placed at 1 m above the floor level.

2.2. Measurements

2.2.1. Growth and carcass measurements

Individual pig weights were measured weekly between 90 and 150 days of age. In addition, the pigs were weighed after a 24-h fasting period at approximately 90, 130, and 150 days of age. Backfat thickness was recorded ultrasonically at the last thoracic vertebra at the beginning of the experiment and the day before they were slaughtered. For each pen, feed intake was measured weekly as the difference between feed allowance and refusal. Every week, feed refusal was sampled for the determination of DM content. During feed distribution, samples were also taken weekly, measured for DM and pooled at the end of the experiment for each replicate. Samples of feed were analysed for ash, protein (N × 6.25), fat, and crude fibre according to the AOAC [1] methods, and for cell wall components (NDF, ADF, ADL) according to Van Soest and Wine [36]. The NE value was estimated according to Noblet et al. [30].

The animals were slaughtered at approximately 150 days of age after a 24-h fasting period. At slaughter, the blood was collected and weighed. The weights of the liver, kidney, spleen, heart, lungs, trachea, full and empty digestive tract, and hot carcass were recorded. After cooling for 24-h at 4 °C, the carcass (with head, legs, diaphragm, and leaf fat) was weighed and the length between the atlas and pubis was measured. The left half-carcass was dissected according to the standard Parisian procedure [12]. The head, ears, legs, tail, diaphragm, leaf fat, backfat, belly, loin, ham, and shoulder were weighed. Lean and fat contents were estimated from the weight of the left-half carcass and those of dissected pieces according to Desmoulin et al.

[12]; these equations were validated in tropical conditions for LW pigs by Rinaldo and Mourot [32]. In addition, lean content was also estimated from the weight of the cuts using the equations developed for CR and LW pigs by Canope et al. [6].

2.2.2. Muscle measurements

The day after slaughter, ultimate pH was measured in the *semimembranosus* (SM) muscle in both replicates and on the *longissimus dorsi* (LD) and *semispinalis* (SS) muscles at the level of the 6th rib only in the second replicate. An approximately 80–100 g sample of LD was taken for drip and cooking loss according to Honikel [19]. Briefly, fresh samples were weighed and suspended in an inflated bag using small hooks. After a 48-h storage period at 4 °C, the samples were weighed again. For cooking loss determination, the samples were placed in vacuum closed plastic bags. After a 30-min cooking period in a temperature controlled water-bath maintained at 75 °C, the bags were cooled during a 40-min period with water maintained at 4 °C. The samples were then taken from the bags, blotted dry, and weighed. The drip and cooking loss was expressed as a percentage of the initial sample weight. The cross sectional area of the longissimus muscle was measured at the level of the 7th rib by planimetry. On the same rib, a 5-g sample of LD was taken for determination of intramuscular fat content according to Folch et al. [16].

2.2.3. Adipose tissue measurements

Immediately after slaughter, samples of adipose tissue were taken from the outer layer of subcutaneous backfat at the level of the last rib (right half-carcass). Adipose cell diameter was determined by analysis of the image following osmium tetroxide fixation according to the Hirsch and Gallian [18] method. The adipose cell number was estimated from the lipid content in backfat tissue and average cell volume according to Di Girolamo [14]. The day after slaughter, a 5-g sample of backfat was taken at the level of the 6th rib for determination of fat content by the method of Folch et al. [16] and fatty acid composition. Fatty acid methyl esters were prepared with boron fluoride-methanol according to Morrison and Smith [27] and analysed by gas-liquid chromatography.

2.3. Statistical analysis

Growth performances, carcass traits, and meat quality parameters were submitted to an analysis of variance (GLM procedure, Statistical System Institute, [34]) including the effect of breed, sex, replicate, block within breed, and breed × sex interaction. For the drip and cooking loss, the weight of the fresh sample of LD muscle was taken as a covariate. A similar model, excluding the replicate effect, was used to analyse ultimate pH in LD and SS.

3. RESULTS

In the first replicate, the actual ambient temperature and relative humidity averaged 26.4 °C and 84.2%, respectively. The corresponding values for the second replicate were 26.2 °C and 84.1%, respectively. Because of a leg problem, one pig was removed (LW castrated male). No interaction between breed and sex was found for any of the criteria studied. As a consequence, the effects of breed and sex are presented separately.

3.1. Growth and carcass traits

The BW differences between LW and CR pigs were 13 and 31 kg at 93 and 150 days of age, respectively (Tab. II). Consequently, average daily gain was significantly higher in LW pigs (830 vs. 559 g per d). On the contrary, the backfat thickness gain was approximately two times higher ($P < 0.001$) in CR than in LW pigs. Feed efficiency was significantly higher in LW pigs (2.6 vs. 3.2). Moreover, sex type had little effect on

Table II. Effect of breed and sex on performance of growing pigs between 90 and 150 days of age.

Traits	Breed[1]		Sex[2]		RSD[3]	Statistical analysis[4]
	CR	LW	F	C		
No. of pigs	32	31	32	31		
Age (d)						
Initial	93.3	93.9	93.6	93.6	1.9	R**
Final	147.4	151.2	149.6	149.2	7.0	R**
Body weight						
Initial (kg)	29.2	42.1	35.6	35.5	4.2	B***, R*
Final (kg)	59.0	89.9	74.2	74.3	4.4	B***, R*
Gain (g per day)	559	830	689	695	70	B***, R*
Backfat thickness						
Initial (mm)	11.0	8.3	9.6	9.7	1.9	B***, R*
Final (mm)	17.5	11.3	13.7	15.2	3.0	B***, S^t, R*
Gain (mm per day)	0.12	0.05	0.08	0.10	0.04	B***, S*, R*
Feed conversion (kg/kg gain)[5]	3.2	2.6	2.8	3.0	0.1	B***, S^t

[1] CR: Creole, LW: Large White;
[2] F: females, C: castrated males;
[3] Residual standard deviation;
[4] From an analysis of variance including the effects of breed (B), sex (S), block within breed (B), and replicate (R) as main effects. Level of significance ^{t}: $P < 0.10$, *: $P < 0.05$; **: $P < 0.01$, ***: $P < 0.001$;
[5] Estimated from feed intake measured on a group of 8 pigs.

growth performance. Average backfat thickness was higher ($P < 0.01$) in castrated males than in females (15.2 vs. 13.7 mm). Feed efficiency tended to be higher in females (3.0 vs. 2.8).

Expressed as a percentage of slaughter BW, the killing-out percentage was higher ($P < 0.001$) in LW than in CR pigs in relation to the lower empty gastro-intestinal tract, liver, kidney, and spleen weights (Tab. III). Moreover, the pig breed did not affect the carcass drip loss (2.62% on average $P > 0.10$). Consequently, the higher dressing weight in LW pigs was related to their higher killing-out percentage (Tab. IV). The carcass length measured between the atlas and the pubis was significantly higher in LW pigs (96.2 vs. 83.6 cm). Expressed as a percentage of BW at slaughter, the head, ears, legs, and tail weights were higher in CR than in LW pigs ($P > 0.001$). The weight of lean cuts (ham and loin; as % of left half-carcass weight) was lower ($P < 0.001$) whereas fat cut weights (backfat and leaf fat) were higher ($P < 0.001$) in CR than in LW pigs. As a consequence, CR carcasses were fatter than LW ones (34.7 vs. 22.4%; $P < 0.001$). Both estimations of carcass lean content were different for CR pigs whereas the same values were obtained for LW pigs. Whatever the breed, the females were leaner than the castrated males (53.3 vs. 47.6%; $P < 0.001$).

3.2. Muscle characteristics

CR pigs exhibited higher intra-muscular fat content in LD muscle than LW pigs (3.45 vs. 2.46%; $P < 0.001$; Tab. V). However, LD cross-sectional area was significantly higher in LW pigs (36.6 vs. 20.0 cm^2). Ultimate pH was higher ($P < 0.01$) in CR for all measured muscles (+0.14, 0.16, and +0.14

Table III. Effects of breed and sex on weights of internal organs, killing-out percentage, and carcass length of growing pigs slaughtered at 150 days of age.

Traits	Breed[1]		Sex[2]		RSD[3]	Statistical analysis[4]
	CR	LW	F	C		
Slaughter BW (kg)	59.0	89.9	74.2	74.3	4.3	B***, R*
Blood (%)[5]	3.33	3.36	3.33	3.36	0.32	
Empty GIT (%)[5,6]	6.32	5.44	5.75	6.03	0.45	B***, S*, R*
Liver (%)[5]	1.90	1.65	1.78	1.78	0.16	B***
Heart + lungs + trachea (%)[5]	1.49	1.46	1.45	1.50	0.19	
Kidney (%)[5]	0.32	0.29	0.30	0.31	0.03	B***, R^t
Spleen (%)[5]	0.15	0.12	0.13	0.14	0.02	B***, S^t
Killing-out percentage (%)[7]	80.9	82.9	82.1	81.7	1.2	B***, R***
Carcass length (cm)[8]	83.6	96.2	90.0	89.6	3.6	B***

[1, 2, 3, 4] see Table II;
[5] Percentage of the slaughter BW;
[6] Gastrointestinal tract;
[7] Hot carcass weight / slaughter BW;
[8] Measured between the atlas and the pubis.

for LD, SM, and SS muscles, respectively). Moreover, LD drip loss was significantly lower (5.96 vs. 10.56%) and cooking loss tended to be lower (30.2 vs. 33.1%) in CR pigs. Meat quality of LD was affected by sex (Tab. V); drip and cooking losses were higher ($P < 0.01$) in castrated males (+1.72 and 3.5%, respectively). However, the results for ultimate pH were less clear; castrated males exhibited a slightly lower ($P <$ 0.05) ultimate pH in LD and in SM whereas pH in SS was similar between sexes.

3.3. Backfat characteristics

Lipid content in backfat was higher in CR than in LW pigs (78.4 vs. 73.9 g per 100 g, $P < 0.01$, Tab. VI). The effect of breed on the backfat fatty acid composition was significant for most of the fatty acids. In particular, saturated and monounsaturated fatty acid contents (C16:0, C18:0, C18:1, and C20:1) were higher ($P < 0.01$) whereas polyunsaturated fatty acid contents (C18:2, C18:3, C20:2, C20:3, and C20:4) were lower ($P < 0.05$) in CR than in LW pigs. The diameter of backfat adipose cells was higher ($P < 0.001$) in CR pigs (66.8 vs. 60.2 µm). The number of adipose cells (expressed per mg of backfat tissue) was higher ($P < 0.01$) in LW pigs (7.04 vs. 5.54×10^6 per g for CR pigs). For both breeds, saturated fatty acid content (C16:0 and C18:0) and adipocyte diameter were higher ($P < 0.05$) whereas polyunsaturated fatty acid concentration tended to be lower in castrated males than in females.

4. DISCUSSION

4.1. Effect of breed on growth performance and carcass trait

As previously observed in Guadeloupe [5, 7, 11] and in Cuba [15, 33], our study confirmed that CR pigs have a slower growth rate and fatter carcasses than genetically improved breeds. Similar results were reported when French local breeds Gascon, Limousin, Basque, Blanc de l'Ouest; [21], Iberian [35], and Meishan pigs [4] were compared with the conventional breeds.

Table IV. Effects of breed and sex on carcass measurements of growing pigs slaughtered at 150 days of age.

Traits	Breed[1]		Sex[2]		RSD[3]	Statistical analysis[4]
	CR	LW	F	C		
Drip loss (%)[5]	2.57	2.67	2.70	2.53	0.37	S^t, R**
Dressing weight (%)[5]	78.8	80.7	79.9	79.6	1.1	B***, R**
Head (%)[6]	7.61	6.44	7.03	7.05	0.54	B***
Ears (%)[6]	0.69	0.47	0.58	0.59	0.11	B***, R**
Legs (%)[6]	4.61	3.95	4.30	4.27	0.47	B***, R**
Tail (%)[6]	0.55	0.46	0.51	0.51	0.10	B***, R*
Composition of carcass (%)[7]						
Ham	21.2	24.0	22.8	22.3	1.1	B***, S^t
Loin	27.0	33.4	30.9	29.4	1.6	B***, S**
Shoulder	13.8	14.4	14.3	13.9	1.3	B^t, R**
Belly	10.6	10.1	10.2	10.5	1.0	B^t, R**
Backfat	17.7	10.8	13.5	15.2	2.6	B***, S*
Leaf fat	2.89	1.38	1.98	2.33	0.64	B***, S^t, R^t
Carcass characteristics (%)[8]						
Lean[8]	43.3	54.8	50.3	47.6	2.8	B***, S***
Lean[9]	40.3	54.8	48.6	46.4	2.0	B***, S***
Fat[8]	34.7	22.4	26.9	30.4	5.1	B***, S*

[1, 2, 3, 4] see Table II;
[5] As % of hot carcass weight;
[6] As % of dressing weight with head, legs, tail, diaphragm, and leaf fat;
[7] As % of left half-carcass weight.
[8] Estimated according to the predicting equations of Desmoulin et al. [12] from the results of the Parisian procedure. Lean (%) = 100 × (296.9 – 201.0 × half carcass (kg) + 1.395 × loin weight (g) + 1.144 × ham (g))/half carcass (kg), R^2 = 0.90; Fat (%) = 100 × (–816 – 1.63 × backfat (g) + 1.43 × leaf fat (g) + 0.52 × belly (g)) / half carcass (kg), R^2 = 0.90.
[9] Estimated according to the predicting equations of Canope et al. [6] from the results of the Parisian procedure. For CR pigs: Lean (%) = 44.1 – 0.49 × ham (%) + 0.53 × loin (%) – 0.41 × backfat (%) – 0.16 × leaf fat (%), R^2 = 0.62. For LW pigs: Lean (%) = 26.2 – 0.38 × ham (%) + 0.80 × loin (%) – 0.58 × backfat (%) – 0.70 × leaf fat (%), R^2 = 0.90.

This result is the consequence of the selection of commercial line pigs in order to increase growth rate, feed efficiency and lean meat content. Therefore, as observed in Meishan [31], the fatter carcass measured in fat-type breeds was mainly related to their low rate of protein deposition (PD). Since the difference between both breeds is probably higher for PD than for energy ME intake, it can be suggested that the energy deposited as lipids is critically higher in CR than in LW pigs.

In CR pigs, the higher carcass adiposity was characterised by both the development of subcutaneous, internal, and intramuscular fat (measured in LD muscle) in accordance with Canope [5]. Higher adipose cell diameter in CR than in LW was consistent with the higher lipid content and larger development of backfat adipose tissues in CR pigs [17]. Bonneau et al. [4] also reported bigger adipose cell diameter in Meishan than in LW pigs. They suggested that this result was connected to an increase of lipogenic

Table V. Effects of breed and sex on muscle chemical composition and lean meat quality.

Traits	Breed[1]		Sex[2]		RSD[3]	Statistical analysis[4]
	CR	LW	F	C		
Longissimus dorsi muscle						
Cross-sectional area (cm^2)	20.0	36.6	29.4	26.3	5.5	B***, S*, R*
Intramuscular fat content (%)	3.45	2.46	2.86	3.10	0.47	B***
pH[5]	5.85	5.71	5.73	5.82	0.15	B*, S^t
Drip loss (%)	5.96	10.56	9.12	7.40	3.02	B***, S*, R***, w*
Cooking loss (%)	30.2	33.1	33.4	29.9	4.29	B^t, S**, w**
Semimembranosus muscle						
pH[5]	5.97	5.81	5.85	5.94	0.19	B**, S^t
Semispinalis muscle						
pH[5]	6.14	6.0	6.03	6.11	0.18	B*

[1, 2, 3] see Table II;
[4] From an analysis of variance including the effects of breed (B), sex (S), block within breed (B) and replicate (R) as main effects. Ultimate pH in longissimus dorsi and in semispinalis muscles were measured in the second replicate only; for these two criteria, the replicate was not included in the preceding model. For the water and cooking losses, the weight of LD fresh sample was taken as covariate. Level of significance ^{t}: $P < 0.10$, *: $P < 0.05$, **: $P < 0.01$, ***: $P < 0.001$;
[5] pH 24 h post mortem.

Table VI. Effects of breed and sex on backfat adipose cell characteristics and chemical composition.

Traits	Breed[1]		Sex[2]		RSD[3]	Statistical analysis[4]
	CR	LW	F	C		
Adipose cells[5]						
Diameter (µm)	66.8	60.2	62.2	65.1	3.0	B***, S*
Nb ($\times 10^6$) per g of backfat	5.54	7.04	6.57	5.93	1.07	B**
Lipid (g per 100 g of backfat)	78.4	73.9	75.1	77.4	5.4	B**, R^t
Fatty acids (% of total)						
C14:0	1.30	1.36	1.30	1.36	0.11	B^t, S^t
C16:0	25.6	24.7	24.7	25.6	1.20	B**, S**
C16:1	1.67	1.46	1.61	1.53	1.10	
C18:0	12.9	11.6	11.9	12.7	1.23	B***, S*
C18:1	38.1	36.2	37.3	37.0	1.84	B***
C18:2	17.3	21.1	19.7	18.5	2.30	B**, S^t
C18:3	0.96	1.31	1.16	1.09	0.28	B***
C20:0	0.24	0.23	0.24	0.23	0.04	
C20:1	0.82	0.75	0.79	0.78	0.13	B**
C20:2	0.73	0.81	0.81	0.74	0.11	B***, S*
C20:3	0.11	0.12	0.12	0.11	0.02	B*
C20:4	0.30	0.37	0.33	0.34	0.11	B*
Saturated	40.0	37.9	38.2	39.9	2.3	B***, S**
Monounsaturated	40.6	38.4	39.7	39.3	2.1	B***
Polyunsaturated	19.4	23.7	22.1	20.7	2.6	B***, S^t

[1, 2, 3, 4] see Table II,
[5] Measured on 22 pigs (6 females and 5 castrated males CR and 6 females and 5 castrated males LW pigs).

enzyme activity in Meishan backfat adipose tissue. In addition, CR pigs have a higher amount of saturated and monounsaturated fatty acids in backfat than LW pigs whereas the polyunsaturated fatty acids content was lower according to Serra et al. [35] when Iberian and Landrace pigs were compared. Moreover, Wood et al. [37] reported strong positive relationships between palmitic and stearic fatty acids and backfat thickness. These results suggest a higher dilution of exogenous polyunsaturated fatty acids with endogenous de novo synthesised fatty acids in CR than in LW, which confirm the higher lipogenic ability in CR pigs. Moreover, the oleic acid content was higher in the backfat adipose tissue of CR, which could be connected to the higher hepatic Δ9-desaturase activity in fat-type pigs [20]. Adipocyte number was 1.3-fold greater in the LW than in CR carcasses; this difference was also reported by Honikel [19] when lean and obese pigs were compared.

The intramuscular fat content in CR pigs (i.e., 3.5%) was consistent with values measured in LD at approximately 100 kg slaughter BW in French local breeds (3.5% on average; [21]), in Meishan (3.8%; [22]) and in Iberian pigs (3.3%; [35]). Moreover, Lazo et al. [24] reported that intramuscular fat content in LD muscle dramatically increased during the growth period, suggesting that for this criterion, the CR pig was superior to the other local breeds. The higher intramuscular fat content in CR pigs was consistent with a fatter carcass and could also be explained by a higher lipogenic capacity in intra muscular adipose tissues as suggested for backfat adipose tissue [29].

The breed type has a noticeable influence on physical appearance at 150 days of age. Creole pigs are longer, and extremities (head, ears, legs, and tail) are more developed than LW pigs. Moreover, Canope [5] showed that skin percentage is higher in CR than in LW pigs. Dauncey and Ingram [10] reported similar results when piglets were exposed to 35 °C versus 10 °C. These results suggested a long-term adaptation to the tropical climate by CR pigs, with an increase of body surface in order to facilitate heat loss in hot conditions.

4.2. Effect of breed on meat quality parameters

For all measured muscles, the ultimate pH was higher in CR than in LW pigs. In particular, the largest difference between both breeds was observed for ultimate pH in SM muscle, which was consistent with the results of Canope [5] and Depres et al. [11]. The ultimate pH of LD muscle of CR pigs (i.e., 5.85) was comparable with values reported in Meishan [3] and in Iberian pigs [35] (i.e., 5.61 and 5.75, respectively). Moreover, CR pigs exhibited lower LD drip loss after 24h-storage and a lower cooking loss than LW pigs. These results imply better technological properties of CR meat. DeVol et al. [13] calculated a positive correlation between the muscle characteristics (ultimate pH, drip and cooking losses), juiciness and firmness of the meat. Moreover, sensory traits such as tenderness, flavour or juiciness were closely related to the intramuscular fat content [25]. This implies the superiority of CR pigs compared to LW pigs in terms of eating quality of fresh meat in accordance with Depres et al. [11]. In addition, the higher saturated fatty acid content in external fat in CR pigs has positive repercussions on the adipose tissue during the transformation of the meat product (i.e., an increase of the melting point) but has negative effects on the nutritional value (i.e., low essential fatty acid supply) [28].

4.3. Effect of sex on carcass trait and meat quality

In castrated males, feed efficiency increased whereas ADG remained constant which resulted in fatter carcasses in castrated males than in females. As previously described, the increase of adipose cell diameter, lipid and saturated fatty acid content in backfat adipose tissue were related to a higher lipogenic ability in castrated males than in females [2, 26]. Logically, a higher intramuscular fat content was found in castrated males than in females in agreement with Barton-Gade [2] and Larzul et al. [23]. However, the effect of sex on ultimate pH was unclear and varied between muscles; ultimate pH tended to be higher in LD and SM in castrated males than in females whereas the sex effect was not significant for SS ultimate pH. In the literature, the effect of sex on ultimate pH remains controversial. Barton-Gade [2] showed a higher SM ultimate pH in castrated males than in females but did not observe any significant effect of sex on the LD pH. Moreover, Larzul et al. [23] reported higher LD ultimate pH in castrated males and they suggested that this effect is related to a lower muscle glycolytic potential of castrated males. The lower LD drip and cooking loss in castrated males than in females highlighted a better technological quality for castrated males. In contrast, Castell et al. [9] did not observe any significant effect of sex on drip and cooking loss. However, these authors reported an improvement of palatability (texture, firmness), visual (colour, marbling) and sensory (flavour) traits in castrated males which could be related to their higher intramuscular fat content.

5. CONCLUSION

The present study confirms the low growth and carcass performance of CR pigs raised in semi intensive conditions. However, the nutritional requirements of CR pigs are not well defined and may probably differ from those of conventional pigs. This suggests that performances of CR pigs could be improved by more adequate nutrition. Consequently, further studies are needed to determine the nutritional requirements of CR pigs. Our study indicates significant differences between breeds for drip loss, backfat fatty acid composition and intramuscular fat content. Thus, we confirm the superiority of CR pigs compared to LW pigs concerning fresh meat quality. Because carcass weights can affect meat and fat characteristics, further studies are necessary to evaluate the effect of breed at a constant slaughter BW.

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