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PAPER

Growth, carcass and meat quality of Casertana, Italian Large White and Duroc x (Landrace x Italian Large White) pigs reared outdoors

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Abstract

To compare growth, skeletal development, carcass traits and meat quality of different genotypes, 10 *Casertana* (CT), 10 Italian Large White (LW) and 10 Duroc x (Landrace x Italian Large White) (DU) crosses, barrows of 90 days of age, were allotted to the same outdoor rearing and feeding conditions. Live weight was recorded and average daily gain (ADG) was calculated. At slaughter (330-day-old) dressing and lean percentages were determined; backfat thickness and loin eye depth were measured. Carcasses were dissected into commercial cuts. Water holding capacity, pH and colour (45 min and 24 h *post-mortem*) were measured. *Longissimus lumborum* muscle samples were collected for cholesterol, α-tochopherol and intramuscular collagen (IMC) analyses. CT compared to DU and LW had the lowest growth rate and skeletal development.

Casertana showed higher backfat thickness, lower lean cut/fatty cut ratio and less lean meat ($P<0.05$). Loin eye depth differed among genotypes with LW>DU>CT ($P<0.05$). CT showed higher red colour of the meat than DU and LW ($P<0.05$). CT compared to LW had the highest hydroxylysylpiridinoline (HLP) crosslink concentration and HLP/IMC ratio, and a lower IMC amount ($P<0.05$). *Casertana* pigs produced meat that could be tougher than that from the improved breed, but more acceptable from the technological point of view.

At eleven months of age bone weight, length and diameter were clearly genetic type-related; differently, the bone maturity was similar among the genotypes studied.

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Introduction

The conventional pig production systems, suited for improved breeds, are generally thought to be associated with negative environmental impact and poor animal welfare, and is perceived to result in reduced meat quality (Bonneau and Lebret, 2010). Thus, in the near future, the pork industry has to propose pig production systems that satisfy consumer and citizen demands for lower environmental impact, improved animal welfare, and better meat quality (Edwards, 2005; Lebret, 2008). The use of native breeds, some of which are free range raised, apart from allowing a wider and more rational exploitation of marginal areas and avoiding the environmental problems of intensive farming, could provide products more acceptable to some consumers (Edwards, 2005). The general belief of a greater consumer acceptance of meat from unimproved pigs, particularly when reared outdoors, has been experimentally supported, in some European breeds: Iberian (Cava *et al*., 2000; Carrapiso *et al*., 2003) and Corsican (Coutron-Gambotti *et al*., 1998). Nevertheless, for a better knowledge of their potential, it is advisable to evaluate their performance and meat quality in comparison to selected breeds under outdoor management.

Intensive outdoor pig production systems have been put into practice (pigs housed in an open building with outside access) in recent years in some parts of the world (Pietrolà *et al*., 2006; Bonneau and Lebret, 2010; Maiorano *et al*., 2013). Interest in intensive outdoor pig production is also growing in Italy (Maiorano *et al*., 2007; Pietrolà *et al*., 2006). These alternatives to traditional indoor systems may also become more common as environmental or animal welfare regulations become more intense. In addition, outdoor pig production systems often have relatively prior to low capital investment, and the ability to be readily expanded.

Casertana (CT) is one of the few Italian local pig breeds that has survived despite the introduction of higher performing breeds. The CT pig is medium-small sized, the coat is bright black and mostly hairless, the standard type exhibits wattles. In the past, the breed was reared in Southern Italy for its productive performance, particularly as regards the fattening tendency (Pietrolà *et al*., 2006). Compared to pig lines highly selected for lean growth efficiency, the CT breed is characterized by slower growth rate and greater fatness (Pietrolà *et al*., 2006), nevertheless there is an increasing interest in Italy for the valorisation of its typical products, for its relevance as genetic reserve and for its usefulness for marginal rural area preservation and exploitation. Recently investigations were performed in order to better characterize genes involved in fattening (Dal Monego *et al*., 2007; D'Andrea *et al*., 2008; Daniele *et al*., 2008). However, very few data are available on growth and carcass composition of the CT breed (Fortina *et al*., 2005; Pietrolà *et al*., 2006; Maiorano *et al*., 2007). In addition, some studies on skeletal development of pig reported that the genotype influences the evolution of the metacarpal growth plate and, consequently, the development of long bones strictly related to composition of gain (muscle/fat/bone ratio) and therefore carcass quality (Field *et al*., 1990a; Filetti *et al*., 2003). Due to lack of interest in this breed in the past, few recent papers on meat and fat characteristics are available (Zullo *et al*., 2003; Maiorano *et al*., 2007; Salvatori *et al*., 2008) and some knowledge (Maiorano *et al*., 2007) exits on CT intramuscular collagen (IMC), responsible for the background toughness of meat (McCormick, 1999) and on yield from a technological point of view (Boutten *et al*., 2000). The purpose of this study was to increase knowledge regarding *Casertana* meat quality and also to compare growth, slaughter performance, meat quality and skeletal development of the CT breed to that of Italian Large White and Duroc x (Landrace x Italian Large White) crosses (one of the most widely used commercial crossbreeds), raised in an intensive outdoor farming system.

Materials and methods

Animals

Animal handling followed the recommendations of European Union directive 86/609/EEC and Italian law 116/92 concerning animal care.

The trial was carried out in Molise (Italy), on an experimental farm situated near the Abruzzi, Lazio and Molise National Park at 800 m asl. Ten *Casertana*, ten Italian Large White and ten Duroc x (Landrace x Italian Large White) barrows of 90±3-day-old, with an average starting live weight of about 22±0.8, 35±1.0 and 43±1.1 kg, respectively, were used. The CT pigs were randomly chosen among the progeny of 6 boars and 16 gilts collected from the different breeding areas. Animals belonged to different litters. The LW and DU pigs were purchased in commercial farms avoiding relatives. Parents of LW where recorded in the herd book. Pigs were randomly distributed into groups of five individuals (according to genetic type) and housed in a pen of 12 m^2 and a height of 2 m, while the front side was completely open to an outdoor paddock of 40 m^2. The pen floor was covered with straw.

Performance were obtained in an intensive outdoor farming system with feed supply and in about one year trial, since these conditions were considered the best to make the rearing of a local breed useful and profitable. During the trial, pigs were fed a diet computed according to standard requirements and supplied on a basis of 9% of metabolic weight (live weight$^{0.75}$). The animals were fed twice daily and during the experimental period had free access to water. The chemical composition of the diets was determined in accordance with the official methods of the Animal Science and Production Association (Martillotti *et al*., 1987). To calculate the food amount to be administered and the overall average daily weight gain, pigs were individually weighed (in the morning after an overnight fast) at the beginning of the trial, monthly and at slaughter. Weight gains were divided into 3 periods according to each feeding phase: growing phase (initial weight-60 kg of live weight), fattening phase (60-100 kg of live weight) and finishing phase (100- final live weight).

Slaughter surveys

After an on-farm fasting period of 8 h, the pigs were individually weighed and transported for 35 min to the abattoir. The pigs were held in lairage for 4 h with free access to water. All the animals were slaughtered the same day at 330±3 days of age, according to procedures described by the Animal Science and Production Association (ASPA, 1991). Hot carcass weights were recorded. Backfat and loin eye depth were measured with Fat-O-Meater (SFK Technology, AIS, Denmark) between the third and fourth lumbar vertebra and over the last rib, at 8 cm from median line. Dressing percentage (hot carcass weight/live weight at slaughter) and lean percentage were calculated. The lean meat content of heavy pigs carcass was calculated (468/2001/CE).

At 24 h *post-mortem*, the left side was dissected into the main commercial cuts (ham, loin, neck, shoulder and fat cuts), to establish the proportion of the different cuts.

Table 1. Pig performances and carcass traits during the trial.

	Genotype			SEM	P
	CT	DU	LW		
No. of pigs	10	10	10		
Growth performances					
ADG (90-330 days), g/d	478^{a}	674^{b}	729^{b}	0.21	0.009
Final live weight, kg	140.1^{a}	202.4^{b}	207.8^{b}	5.99	0.001
Carcass traits					
Carcass weight, kg	112.0^{a}	161.9^{b}	168.6^{b}	4.90	0.001
Dressing out, %	80.2	80.0	81.1	0.59	0.771
Backfat thickness, cm	5.1^{b}	3.4^{a}	3.1^{a}	0.21	0.001
Loin eye depth, cm	5.2^{a}	8.3^{b}	9.3^{c}	0.36	0.001
Lean meat yield, %	47.1^{a}	51.3^{b}	52.8^{b}	0.63	0.001
Remarks on left side					
Ham, %	29.2	29.1	29.6	0.35	0.476
Shoulder, %	13.8^{a}	16.5^{b}	17.0^{b}	0.39	0.026
Loin, %	8.2^{a}	11.8^{b}	12.2^{b}	0.38	0.016
Neck, %	5.3^{a}	6.5^{b}	6.9^{b}	0.16	0.021
Lean cuts yield$^{\circ}$, %	56.5^{a}	63.9^{b}	65.8^{b}	0.90	0.012
Fatty cuts yield$^{\#}$, %	31.4^{b}	24.7^{a}	23.8^{a}	0.75	0.016
Lean to fat cut ratio	1.81^{a}	2.60^{b}	2.78^{b}	0.09	0.036

CT, *Casertana*; DU, Duroc x (Landrace x Italian Large White); LW, Italian Large White; ADG, average daily gain. $^{\circ}$Ham, shoulder, loin, neck; $^{\#}$backfat, belly, jowl, kidney fat. $^{a-c}$Different superscript indicate statistical differences ($P<0.05$).

Meat quality

Longissimus lumborum (LL) muscle samples were collected (after 24 h at 2 to 4°C), between the 2nd to the 5th lumbar vertebra, vacuum packaged and stored frozen (–40°C) until cholesterol, vitamin E (alpha-tocopherol) and intramuscular collagen (IMC) analyses.

pH, colour and water holding capacity

On LL the following determinations were carried out: i) pH was recorded 45 min (pH_{45}) and 24 h (pH_{24}) *post-mortem* using a portable HI 9625 pH meter (Hanna Instruments, Padova, Italy); ii) colour parameters L*, a* and b*, with a Minolta chromameter CR300. The Hue angle (tang^{-1} (b*/a*) (180/π)) and Chroma ($(a^{*2} + b^{*2})^{1/2}$) were also computed. Reflectance measurements were performed after the samples had oxygenated in air for at least 30 min by which time measurements were stable (Škrlep and Čandek-Potokar, 2006). The temperature (T_{45} min and T_{24} h), measured at approximately 5 cm depth in the muscle, was from 38.9 to 39.5 °C and 3.2 to 3.4 °C at 45 min and 24 h *post-mortem*, respectively; iii) water-holding capacity (WHC) was determined as free water by the filter paper press method (Grau and Hamm, 1952).

Cholesterol analysis

Cholesterol was extracted using the method of Maraschiello *et al*. (1996) and then quantified by HPLC. A Kontron HPLC (Kontron Instruments, Milano, Italy) model 535 equipped with a C18 reverse-phase column (250x4.6 mm x 5 µm) (Phenomenex, Torrance, CA, USA) was used. The mobile phase was acetonitrile/2-propanol (55:45 v/v) at a flow rate of 1.2 mL/min. The detection wavelength was 210 nm and retention time was 13.89 min.

Alpha-tocopherol analysis

The levels of Vitamin E in the meat were determined and quantified according to the method described by Zapel and Csallany (1983) and then quantified by HPLC model 535 (Kontron Instruments) equipped with a C18 reverse-phase column (250x4.6 mm x 5 µm) (Phenomenex). The mobile phase was 100% methanol at a flow rate of 1.5 mL/min. The detection wavelength was 292 nm and retention time was 4.1 min.

Collagen analysis

In order to study IMC properties, approximately 100 g of muscle (wet weight) were thawed, trimmed of fat and epimysium, lyophilized for 48 h, weighed, and hydrolyzed in Duran tubes in 6 N HCl at 110°C for 18 to 20 h (Etherington and Sims, 1981) for determination of hydroxyproline (Woessner, 1961) and crosslinking. All analyses were carried out in duplicate. IMC concentration was calculated, assuming that collagen weighed 7.25 times the measured hydroxyproline weight (Eastoe and Leach, 1958) and expressed as µg hydroxyproline/mg of lyophilized tissue. Hydroxylysylpyridinoline (HLP) concentration, the principal non-reducible crosslink of muscle collagen (McCormick, 1999), was determined using the high pressure liquid chromatography (HPLC) procedure developed by Eyre *et al.* (1984). Hydroxylysylpyridinoline was expressed as moles of HLP per mole of collagen and also as µg HLP/mg of lyophilized tissue.

Bone analysis

Distal portion of bones of anterior legs were collected from each carcass and the 3rd and 4th metacarpal (MC) bones were taken. Bones were cleaned of all connective tissue, measured for length, diaphyseal diameter and weighed. Dry weight of the 4th MC was recorded after 7 d at 100°C in a drying oven for moisture determination. Growth plate width on the distal end of the 3rd MC was measured after silver nitrate staining (Maiorano *et al.*, 1999) of 4 longitudinal slices 2 mm thick cut on the sagittal plane. Three width measurements per bone slice were made on different anatomical locations 1/4, 1/2 and 3/4 the distance across the bone slice with microscopic examination. Therefore, the 12 measurements on each MC growth plate were averaged.

Statistical analyses

One way analysis of variance (ANOVA) was performed for all variables considered in the study (SPSS, 2010). Scheffé's test was applied to compare the mean values of the genotype. Simple correlations were calculated among ultimate pH and colour variables using the same statistical package. Each individual pig was considered as the experimental unit.

Table 2. Average value for physical traits of *Longissimus lumborum* muscle.

	Genotype			SEM	P
	CT	DU	LW		
pH$_{45}$	6.17^{b}	6.13^{b}	5.94^{a}	0.05	0.020
pH$_{24}$	5.51	5.41	5.49	0.02	0.271
WHC, %	15.9	17.5	17.5	0.59	0.444
Colour 45 min *post-mortem*					
L*	35.47	35.53	37.82	0.93	0.514
a*	6.01	5.69	5.47	0.26	0.705
b*	1.22	0.86	1.19	0.22	0.770
Chroma	6.12	5.74	5.60	0.30	0.662
Hue	11.48	8.61	12.26	1.36	0.143
Colour 24 h *post-mortem*					
L*	39.60	43.43	42.24	1.04	0.320
a*	8.99^{b}	6.80^{a}	7.85^{a}	0.36	0.038
b*	2.10	2.84	2.91	0.27	0.416
Chroma	9.26	7.34	8.35	0.42	0.415
Hue	13.13^{a}	22.66^{b}	20.34^{b}	1.54	0.042

CT, *Casertana*; DU, Duroc x (Landrace x Italian Large White); LW, Italian Large White. $^{a-b}$Different superscript indicate statistical differences (P<0.05).

Table 3. Average value for cholesterol and α-tocopherol content, and intramuscular collagen properties of *Longissimus lumborum* muscle.

	Genotype			SEM	P
	CT	DU	LW		
Cholesterol, mg/100g	66.24	65.10	61.03	1.37	0.271
α-tocopherol, µg/g	2.96	3.42	2.99	0.19	0.369
IMC, µg/mg	19.88^{a}	26.72^{b}	24.90^{b}	1.17	0.018
HLP, µg/mg	5.30^{b}	4.24^{ab}	2.60^{a}	0.41	0.004
HLP/IMC, mol/mol	0.187^{b}	0.113^{ab}	0.081^{a}	0.15	0.001

CT, Casertana; DU, Duroc x (Landrace x Italian Large White); LW, Italian Large White; IMC, intramuscular collagen; HLP, Hydroxylysylpyridinoline. $^{a-b}$Different superscript indicate statistical differences (P<0.05).

Results and discussion

Growth and slaughter performance

In this trial, slaughter weight in LW and DU were higher than that recommended by the Italian pig industry because it was necessary to approach to the minimum slaughter weight (140 kg) for CT pigs. Growth performance and carcass traits are shown in Table 1. In agreement with the recent findings of Pietrolà *et al.* (2006), CT pigs had lower (P<0.05) average daily gain (ADG) than the other two genotypes. The lower growth rate of the unimproved breed confirms the findings found in other Italian (Acciaioli *et al.*, 2002; Filetti *et al.*, 2003; Franci *et al.*, 2003) and European (Legault *et al.*, 1996; Serra *et al.*, 1998; Alfonso *et al.*, 2005) native breeds.

As a consequence of the differences in growth rates and in initial live weight among genetic types studied, the slaughter and carcass weights in CT were lower than those of the LW and DU (P<0.05) pigs. No statistical differences (P>0.05) in slaughter and carcass weights were detected between LW and DU pigs. No genetic type differences were found for dressing out. Comparisons involving CT and other breeds are scarce in literature, but in contrast with the present results, Pietrolà *et al.* (2006) found some significant differences in dressing percentage between CT (81.4%) and Italian Large White (79.8%) pigs slaughtered at 151 and 179 kg of live weight, respectively. This different trend may be due to both different slaughter weight and fat deposition between pigs used in this experiment and those of Pietrolà *et al.* (2006). Differently and in agreement with our findings, Alfonso *et al.* (2005) did not detect any difference in dressing percentage between Basque and Large White pigs. However, contradictory data regarding the dressing percentage comparison of native and improved pigs exist (Legault *et al*., 1996; Serra *et al*., 1998; Franci *et al*., 2003).

As expected, CT were fatter than DU and LW pigs, both for backfat thickness and fatty cut yield (P<0.05), while LW and DU pigs had higher (P<0.05) lean meat, and shoulder, loin and neck percentages, as well as lean cut yield and lean cuts/fatty cuts ratio. Comparable measurements for backfat thickness were found by Fortina *et al*. (2005) and Pietrolà *et al*. (2006) on CT pigs and by Franci *et al*. (2005) on *Cinta Senese* pigs, slaughtered at different ages and weights. Moreover, significant differences (P<0.05) were detectable among genetic groups with regard to loin eye depth with LW>DU>CT. These findings confirm the general higher fat deposition of native breeds compared to improved pigs (Serra *et al*., 1998; Franci *et al*., 2005) and, in addition, they confirm a large amount of variation in the genetic capacity to deposit lean tissue that exists among pigs. Ham percentage did not differ significantly (P>0.05) between the three genetic types, although the hams of the commercial pigs were markedly (P<0.01) heavier (LW= 24.9 kg, DU=23.6 kg) than those of the CT (16.3 kg), because ham weights are related to slaughter weight (Alfonso *et al*., 2005).

Meat quality

The results for pH, WHC and colour are reported in Table 2. It is well known that the ultimate pH of the muscle is an important contributing factor to meat quality; it is in turn dependent on the stress *ante-mortem*, the type of breeds and the genetic variation within breeds (Terlouw, 2005). Genetic type influenced pH_{45} (P<0.05), but pH_{24} values were not significantly (P>0.05) affected and they are in acceptable range (from 5.5 to 5.8). Compared to CT and DU, LW showed the lowest pH_{45} value (5.94), indicating a faster rate of *post-mortem* glycolysis (Murray *et al*., 1989). Local breeds are less susceptible to stress *ante-mortem* factors than improved pigs (Alfonso *et al*., 2005).

Genetic type did not affect WHC or colour measurements, except for red and hue indexes recorded 24 h *post-mortem*. Compared to the meat from improved pigs, the meat from CT pigs exhibited a redder colour (higher a* value; P<0.05) and lower hue value (P<0.05). The literature (Franci *et al*., 2005; Estévez *et al*., 2006) reports a meat more red in native breeds than in improved ones; this might also be explained at least in part by the growth of pigs and in part by the ultimate pH. In fact, Latorre *et al*. (2008) reported a negative correlation between daily growth and a* value in three different pig genotypes. In addition, DeVol *et al*. (1988) revealed a high positive correlation between *Longissimus* muscle colour and pH. On the other hand, in the present study was found a negative correlation (P<0.01) between pH_{24} and L* (r= –0.587), a* (r= –0.482) and b* (r= –0.463) values. Meat colour is the most important factor affecting consumer acceptance, purchasing decisions and satisfaction of meat products (Muchenje *et al*., 2009). Colour of pork is strongly associated with expected meat quality (Bredahl *et al*., 1998). Meat purchasing decisions are influenced by colour more than any other quality factor because consumers use discolouration as an indicator of freshness and wholesomeness (Mancini and Hunt, 2005).

Cholesterol content in carcasses of animals has long been identified as the single most important characteristic of overall meat quality (Newman, 1993) and limitation in cholesterol intakes, as well as fat intakes, is thought to be an important measures to prevent obesity and hypercholesterolaemia, conditions that are considered to predispose to various chronic diseases of the circulatory system (Chizzolini *et al*., 1999; Jiménez-Colmenero *et al*., 2001).

Genetic type did not significantly influenced the cholesterol content in LL muscle (Table 3). Similarly, Harris *et al*. (1993) found no effect of breed on cholesterol content of *Longissimus* and *Semitendinosus* muscles. Conversely, Lan *et al*. (1993) comparing muscle cholesterol content of several genetic types observed significant differences, but not among all breed studied. There are limited information in literature on the cholesterol content of the meat from CT pigs but the values detected in the present study for all the studied samples were quite high than that found by Maiorano *et al*. (2007) and Salvatori *et al*. (2008). The cholesterol content of pork reported in the literature varies. The discrepancy can be attributed to a number of factors, such as muscle type, age/weight of animal, environmental factors, feeding, and rearing system (Bragagnolo and Rodriguez-Amaya, 2002), as well as the use of different methodologies for cholesterol quantification or for sampling (Bragagnolo and Rodriguez-Amaya, 2002). All these factors make it very difficult to establish fair comparison, however cholesterol amount found in this experiment generally agrees with reported values (Harris *et al*., 1993; Lan *et al*., 1993; Chizzolini *et al*., 1999).

Muscle α-tocopherol concentration was similar among genotypes (Table 3), according to Nilzén *et al*. (2001). Similar values of α-tocopherol concentration have been noted in muscle from female, castrated male and entire male pigs (Högberg *et al*., 2004). Vitamin E is a powerful lipid-soluble antioxidant in biological systems, capable of breaking the chain of lipid oxidation in the cell membranes, thereby preventing the formation of rancid flavour during storage (Buckley *et al*., 1995).

IMC characteristics are shown in Table 3. Genetic type clearly influenced IMC properties. IMC amount was lower (P<0.05) for CT in comparison to DU and LW, while DU and LW did not differ (P>0.05). Muscle HLP concentration (µg/mg) and collagen maturation (HLP/collagen) were higher (P<0.05) for CT in comparison to LW, with intermediate (P>0.05) values for DU. We supposed that these findings could be related both genotype and growth rate. In fact, this result partially confirms our previous research (Maiorano *et al*., 2003), reporting a higher collagen maturation (0.251 moles of HLP per mole of collagen) in native pigs (*Cinta Senese* breed) than in improved breeds. Other authors have reported a marked genetic effect on collagen properties in pigs (Lebret *et al*., 2001), beef (Campo *et al*., 2000) and lamb (Heinze *et al*., 1986). In addition, the literature documents growth rate-dependent

Table 4. Average values of the characteristics of metacarpal bones.

	Genotype			SEM	P
	CT	DU	LW		
Third metacarpal bone					
Fresh weight, g	22.7^{a}	33.9^{b}	35.4^{b}	1.47	0.002
Length, cm	7.4^{a}	8.5^{b}	8.6^{b}	0.14	0.013
Diameter, cm	1.6^{a}	1.8^{b}	1.9^{b}	0.04	0.041
Growth plate, mm	0.37	0.41	0.37	0.01	0.111
Fourth metacarpal bone					
Fresh weight, g	24.6^{a}	36.4^{b}	35.9^{b}	1.38	0.012
Length, cm	7.5^{a}	8.5^{b}	8.7^{b}	0.13	0.026
Diameter, cm	1.8^{a}	2.1^{b}	2.1^{b}	0.03	0.032
Moisture, %	21.2	22.0	21.0	0.65	0.990

CT, *Casertana*; DU, Duroc x (Landrace x Italian Large White); LW, Italian Large White. $^{a-b}$Different superscript indicate statistical differences (P<0.05).

shifts in muscle collagen amount and/or crosslinking (Aberle *et al*., 1981; McCormick, 1994; Harper, 1999; Maiorano *et al*., 2007). During rapid growth, newly synthesized collagen dilutes older collagen and is less crosslinked than the pre-existing collagen (Etherington, 1987), with a positive effect on meat tenderness (McCormick, 1994). An increase in IMC crosslinking leads to an increased IMC thermal stability, which has been related to undesirable changes in eating quality of meat (McCormick, 1999). On the other hand, Boutten *et al*. (2000) showed a positive relationship between collagen crosslinking and technological yield, demonstrating that collagen characteristics are also indicators of technological behaviour.

Metacarpal bone characteristics are shown in Table 4. Bone weight, length and diameter were clearly genetic type-related; CT pigs possessed smaller and lighter bones than other genetic lines (P<0.05). Nevertheless, bone moisture and growth plate width (the site of the longitudinal bone growth) did not change significantly (P>0.05) among genotypes, indicating a similar bone maturity. Similar measurements of growth plate width observed in experimental pigs of the same age (330 days), confirm that growth plate width is a good indicator of chronological age (Field *et al*., 1990b). No data exist on CT skeletal development, which strongly influences carcass and meat quality (Field *et al*., 1990b; Filetti *et al*., 2003), but Mayoral *et al*. (1999) suggested that non-selected genotypes, such as Iberian pigs, were slower maturing because bone tissue growth continues at ages older than in improved genotypes.

Conclusions

In this work, new data describing productive performance, meat quality and skeletal development of the CT breed are reported. The CT pig was prone to adipogenesis and showed lower growth rate, lean cuts yield and skeletal development when compared to LW and DU pigs. This considerable difference is likely to be due to the fact that the CT was never submitted to modern selecting schemes and with the goals of fast growth rate and lean meat production. In addition, it should be emphasized the overall high values for HLP in the CT pigs, responsible for the positive effect on yield from a technological point of view. The productive aptitude of this Italian native pig suggests that the breed could be used for typical products.

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