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Comparison of the performances of Nero Siciliano pigs reared indoors and outdoors. 1. Growth and carcass composition

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Abstract

A total of 78 female and male Nero Siciliano pigs were used. Forty-one pigs were reared following the traditional management system, 37 pigs were reared in pens with a small outdoor paddock and fed to appetite using commercial rations according to the growing period. Both male and female pigs were castrated. All pigs were weighed and measured periodically. Body measurements included height at withers, chest girth, body length, width at shoulders and at rump. Age and body weight at slaughter ranged respectively from 371 to 572 days and from 79 to 113 kg. The carcasses were weighed and dissected into lean, fat and bone cuts. In the early and final stages indoor-pigs grew faster than those reared outdoors. Trends in body length were similar for the two rearing systems, for width at shoulders and rump, chest girth and height at withers, indoor pigs showed higher values than the outdoor ones. Carcasses of similar weight were longer in outdoor than in indoor pigs but the latter showed greater subcutaneous fat thickness. Outdoor pigs had the lowest dressing percentage and the highest percentage of lean cuts, such as shoulder and ham, but not of neck and loin. Sex did not significantly affect the analysed characteristics.

Keywords: Nero Siciliano; Pig; Outdoor; Morphological measures; Carcass composition

1. Introduction

There are no reliable data on the performance of most endangered local pig breeds. The evaluation of these performances will help in assessing the conservation value of these breeds. Considering that resources for conservation are scarce, breed performance has been suggested as a criterion to be used in the selection of breeds for conservation (Ruane, 1999). Moreover, performance evaluation may reveal characteristics of the breed that can be used to increase its economic value and, consequently, its self-sustainability. It is known that local breeds often decline because of lack of economic competitiveness (Gandini & Giacomelli, 1987).

Among the numerous pig breeds and ecotypes present in Italy at the beginning of the last century, only five survived the industrialisation of pig breeding, though with small population numbers (Gandini, Fortina, Franci, Madonia & Matassino, 2001). Among these, the Nero Siciliano pig is today farmed in a restricted area of Sicily, with about 700 sows. Its survival is characterised by both the possibility of obtaining quality meat products and its adaptation to an harsh environment (Chiofalo & Zumbo, 2001). Although the breed is probably still declining in numbers, these characteristics are giving rise to renewed interest.

The literature on performances of local pig breeds reared under extensive systems is still scarce (Mayoral, Dorado, Guillèn, Vivo, Vàzquez, & Ruiz, 1999; Serra et al., 1998; Legault et al., 1996). Mayoral et al. (1999) suggested that non-selected genotypes, such as Iberian pigs, could be ascribed to a slow maturing type in as much as bone tissue growth continues at ages older than

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in improved genotypes. Establishing the performances of local breeds may involve both consistent differences between rearing environments and of interactions between management and breed characteristics. Thus comparisons of breeds in different environments is needed. For example, the Iberian pig reaches maturity (160 kg live weight) under the traditional extensive system in 16–18 months, but this period can be reduced to 12–14 months if appropriate feed integration is provided when natural pastures are depleted (Dobao, Rodrigagñez, Silio, & Toro, 1988). Greater differences can be observed by comparing extensive and intensive rearing systems. This theme has been investigated in improved breeds in relation to environment protection and animal welfare (Berger, Dagorn, Le Denmat, Quillien, Vaudelet, & Signoret, 1997; Enfält, Lundström, Hansson, Lundeheim & Nyström, 1997; Jonsäll, Johansson & Lundström, 2001; Van der Wal & Mateman, 1993).

It is conceivable that comparisons of theperformances of the Nero Siciliano pig in the traditional low input and in higher input farming systems may help to understand breed characteristics and to increase the use of the breeds. The aim of this investigation was to study the effects of the traditional extensive and the indoor rearing systems on growth, performances and carcass characteristics of this breed.

2. Materials and methods

A total of 78 female and male Nero Siciliano pigs were used. Forty-one pigs, from six herds, born from July to December, were reared following the traditional management system. All herds were located on the Nebrodi mountains in Sicily. The feeding was based on natural pastures, which included woods mainly composed of the *Quercus genus* (*Q. ilex, Q. virgiliana, Q. gussonei, Q. cerris, Q. suber* and, more rarely, *Q. robur*) and beech trees (*Fagus selvatica*), grasslands and Mediterranean bush. In periods of low pasture availability, feeding was supplemented with cereals and field beans (*Vicia faba*). Thirty-seven pigs were born and reared in pens with a small outdoor paddock and, after weaning, fed with commercial mixtures according to the growing period (Table 1). To avoid mating with free-ranging boars and to follow the traditional management system, both males and females were castrated at about 3 months of age.

All pigs were weighed and measured periodically, from weaning to slaughter, with a minimum interval of 2 months between measurements. Body measurements included height at withers, chest girth, body length, width at shoulders and at rump. Pigs were slaughtered at different ages and weights, in order to consider the traditional pig farming characterised by slaughtering during the winter months and by the production of carcasses suitable for meat production. Age and body weight at slaughter ranged respectively from 371 to 572 days and from 79 to 113 kg (Table 2). After slaughter, the thickness of outer and inner layers of backfat on the dorsal midline opposite to the first and last ribs, and to the point over the *M. gluteus medius* where the backfat is thinner, was recorded. Carcass length and chest deep were taken according to the ASPA (1991) procedure. The day after slaughter carcasses were weighted and right sides were dissected into lean, fat and bone cuts.

Data were analysed using the following linear model (SAS, 1997):

$$Y_{ijk} = \mu + R_i + S_j + b_i \times X_{ijk} + e_{ijk}$$

where Y_{ijk} is the kth observation of the ith rearing system (R) and of the jth sex (S), μ is the overall mean, the b_i term is the regression coefficient of the covariate (X) and e_{ijk} is the error which is an independent random variable. The covariate, age or carcass weight depending upon the parameter considered, was tested up to third degree equation. To study the development growth pattern, body measurements were analysed as a function of live weights, by means of the allometric function $Y = aX^b$ (Huxley, 1932). Analysis was performed on data transformed logarithmically ($\log_{10}$).

Table 1
Chemical composition of the diet in different growth stages (percentage on wet basis)

		Starter (70–105 days)	Growing (106–260 days)	Fattening (261–450 days)
Dry matter	%	13	13	13
Crude protein	%	19	18.20	16.5
Ether extract	%	5.8	5	5
Crude fibre	%	3.5	4.3	5
Ash	%	5.8	5.39	6
Lysine	%	1.4	1.1	0.85
Vitamin A	U.I./kg	12.600	12.600	12.600
Vitamin D3	U.I./kg	1.260	1.260	1.260
Vitamin E	mg/kg	26	26	26
Copper	mg/kg	154	154	100
Sodium salinomycin	mg/kg	60	60	60

Table 2
Mean age and weight at slaughter

	Indoor	Outdoor
No. of animals	37	41
Age at slaughter (days)	448.14; range 371–474	486.45; range 420–572
Weight at slaughter (kg)	101.96; range 78.8–123	88.25; range 66.6–113

3. Results and discussion

Trends of live weight in relation to age are shown in Fig. 1. During the first 120 days, indoor-pigs grew faster than outdoor ones. From 120 to 300 days, indoor and outdoor growth trends were parallel. Subsequently, growth rates diverged and indoor-pigs grew faster with an average daily gain of 400 g in the last 100 days, 280 g higher than registered in the previous 100 days. Outdoor-pigs showed an average daily weight gain of 200 g during the entire rearing period, almost constant until 480 days of age, when it showed a decrease. In Iberian pigs Mayoral et al. (1999), observed daily gains during fattening periods which were twice as high as those in the previous periods. However, outdoor growth in different regions cannot be compared because of differences in acorn productivity. Lower growth performances in outdoor versus indoor rearing have been observed independent of food supply in both commercial (Enfält et al., 1997) and local breeds (Labrou, Goumy, Gruand, Mourot, Neelz, & Legault, 2000). These differences have been related to the higher energy requirements for physical exercise and thermoregulation in outdoor pigs (Enfält et al., 1997). Figs. 2–4 illustrate, for both indoor and outdoor pigs, the changes in body measurements in relation to age. Trends in body length were similar in the two rearing systems. For all other measurements, width at shoulders and rump, chest girth and height at withers, indoor pigs showed greater values than the outdoor ones, in accord with their greater live weight gain, as shown by estimated means (Table 3).

In Table 4 the allometric coefficients of body measurements are shown. These coefficients allow one to better understand the evolution of body proportions with growth. The isoauxesis condition of a linear measurement with respect to another of third degree, such as live weight, is expressed by the allometric coefficient of 0.333 (Walstra, 1980), instead of unity, and lower or higher coefficients indicate, respectively, slower or faster relative growth. For width at shoulders, width at rump and chest girth, in both outdoor and indoor pigs, we observed rates that were faster than live weight, that corresponded to late growth. Similar observations were reported for another Italian local breed, the Cinta Senese (Acciaioli, Pugliese, Bozzi, Campodoni, Franci, & Gandini, 2002; Campodoni, Acciaioli, Bozzi, Pugliese & Franci, 1998). No significant differences in allometric coefficients were observed between the rearing systems with respect to width at shoulders, width at rump and chest girth, but height at withers and body length were

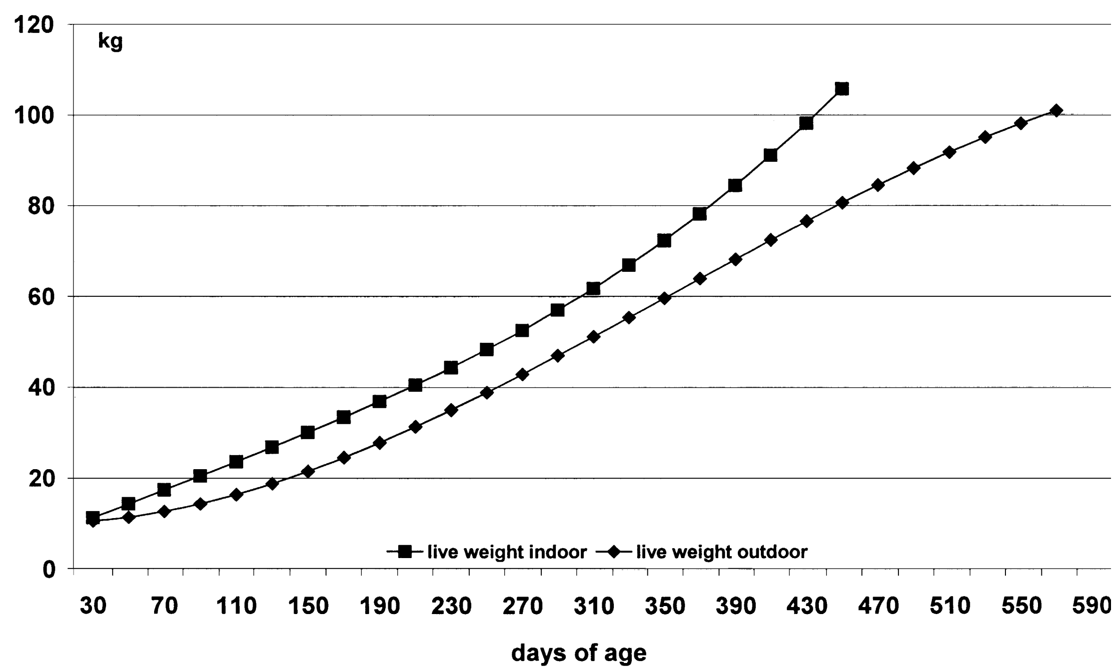

Fig. 1. Live weight as a function of age (days).

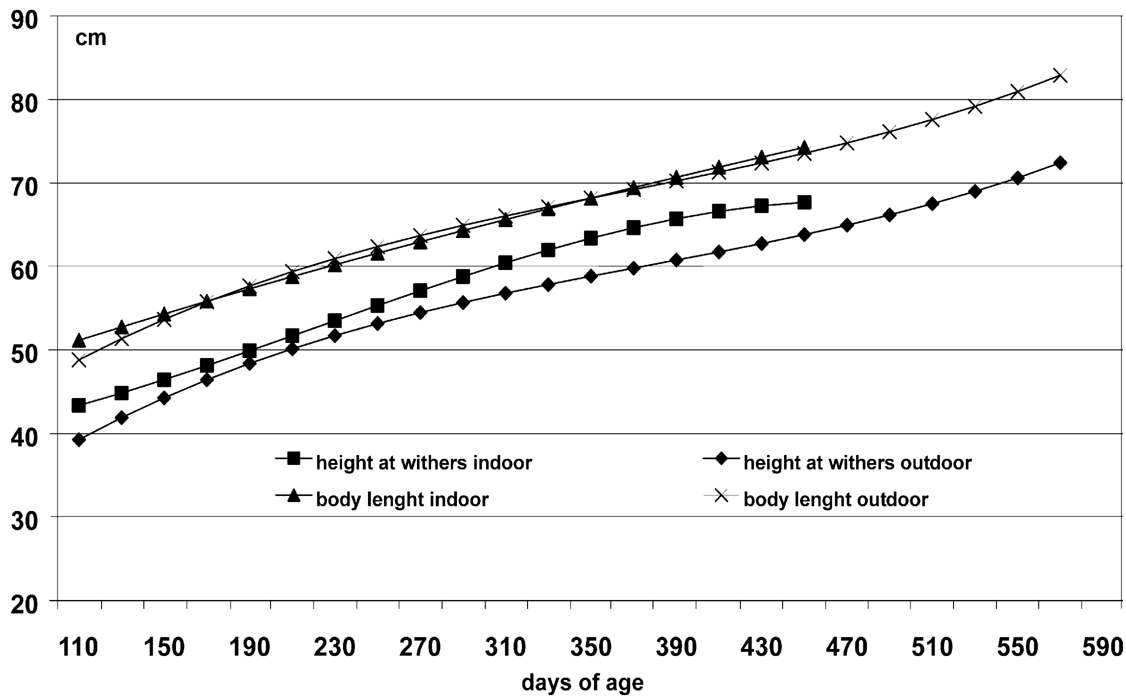

Fig. 2. Height at withers and body length in relation to age (days).

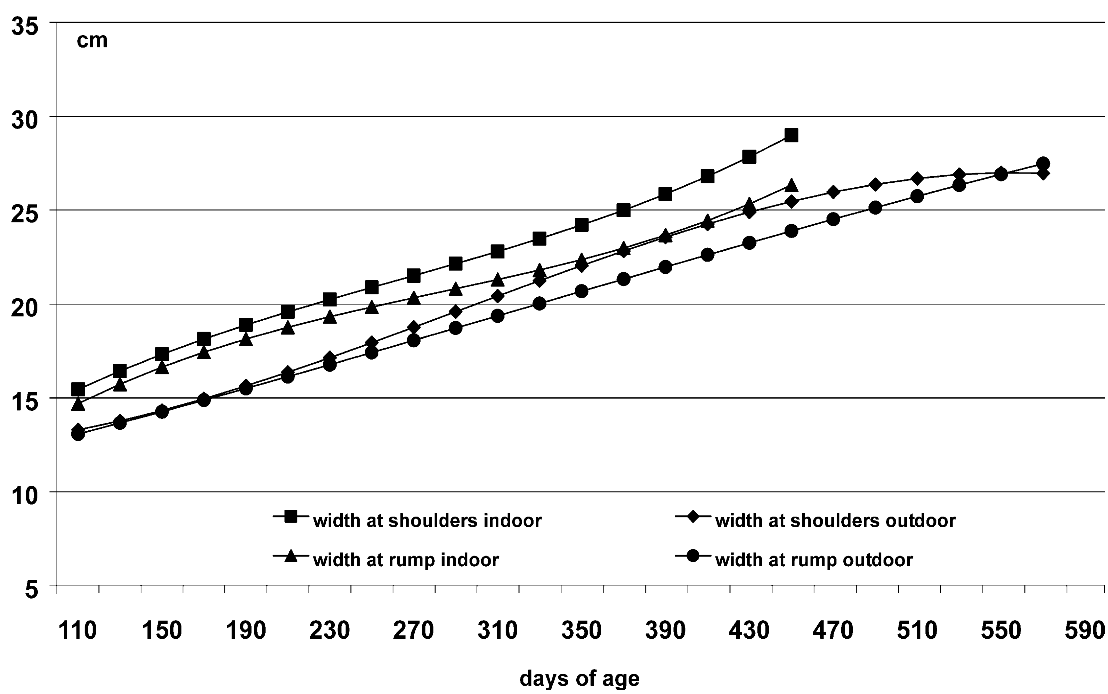

Fig. 3. Width at rump and shoulders in relation to age (days).

significantly greater in the outdoor group. To better explain these differences, estimates of body measurements at 100 kg live weight are given in Table 5. Pigs reared outdoors showed significant differences for height at withers, shoulder width and body length, which meant higher skeletal development related to the greater age of these animals. For the remaining body measurements, which are related to both skeletal and muscle development, differences between rearing systems were not significant. Carcass measurements are given in Table 6. In accordance to the observations on body length of live animals (Table 5), carcasses of similar weight were longer in outdoor than in indoor reated pigs. No differences were observed in thoracic depth.

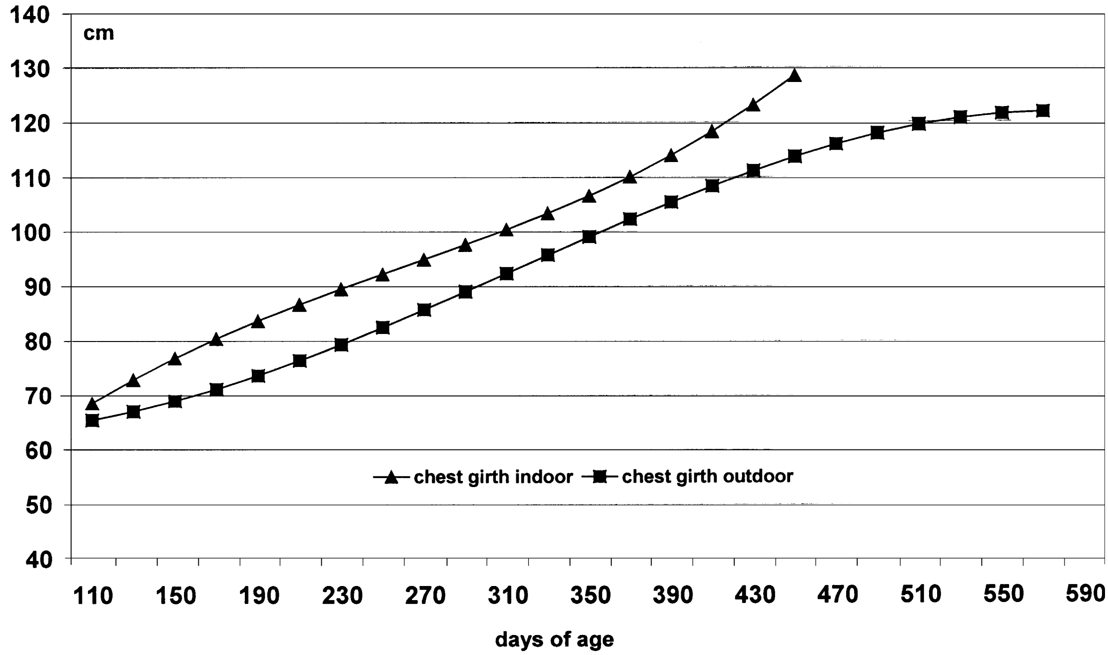

Fig. 4. Chest girth in relation to age (days).

Table 3
Live weight (kg) and body measurements (cm) estimated at 250, 350 and 450 days of age

Days of age	250			350			450			RSD
	Indoor	Outdoor	Significance	Indoor	Outdoor	Significance	Indoor	Outdoor	Significance	
Live weight	48.30	38.86	$P<0.01$	72.41	59.68	$P<0.01$	105.71	80.55	$P<0.01$	11.44
Height at withers	55.27	53.21	$P<0.01$	63.22	58.94	$P<0.01$	67.30	64.03	$P<0.01$	5.45
Shoulder width	20.89	17.99	$P<0.01$	24.23	22.24	$P<0.01$	29.01	25.88	$P<0.01$	2.19
Rump width	19.86	17.43	$P<0.01$	22.40	20.70	$P<0.01$	26.39	23.93	$P<0.01$	2.10
Body length	61.59	62.52	n.s	68.13	68.12	n.s.	74.10	73.27	n.s.	6.77
Chest girth	92.32	83.51	$P<0.01$	106.58	99.36	$P<0.01$	128.51	113.52	$P<0.01$	8.08

Table 4
Mean allometric coefficients (b) of body measurements in relation to live weight

	Indoor		Outdoor		Significance
	b	S.E.	b	S.E.	
Height at withers	0.297	0.007	0.348	0.005	$P<0.01$
Shoulder width	0.384	0.008	0.377	0.005	n.s.
Rump width	0.361	0.008	0.377	0.005	n.s.
Body length	0.269	0.007	0.286	0.005	$P<0.05$
Chest girth	0.377	0.008	0.368	0.006	n.s.

The greater length of outdoor animals was related to their greater ages, considering that physical exercise did not seem to influence skeletal development (Enfält, Lundström, Hansson, Karlsson, Essèn-Gustavsson, & Håkansson, 1993). Generally, pigs reared indoors showed greater fat thickness than the outdoor ones. Thicker fat in indoor pigs at the first thoracic vertebra was due to the inner layer, while the higher value over the M. *gluteus medius* was due to the outer layer only. The lower backfat thickness of outdoor pigs may be related to the slower growth rate, at the same carcass weight, according to others (Enfält et al., 1997; Warriss, Kestin, & Robinson, 1983) which demonstrated that slower growing pigs favour muscle deposition with respect to fat, resulting in leaner carcasses. Dressing and carcass composition are given in Table 7. No significant differences were found for dressing and loin percentages. Outdoor animals showed an higher percentage of lean cuts, in particular for ham and shoulder, but not for neck and loin. Enfält et al. (1997) suggested that outdoor rearing would induce greater development of glycolytic muscles, particularly muscles of the ham, and would not affect the growth of M. *longissimus dorsi*. Outdoor pigs had less backfat, but more kidney fat. No significant differences were observed for the two other fat cuts, belly and jowl, or for total bone cuts. These results differed from those of a trial on Cinta Senese pigs reared outdoor and indoor, where the former

Table 5
Body measurements (cm) estimated at 100 kg of live weight

	Indoor	Outdoor	Significance
Height at withers	68.59	71.99	$P<0.01$
Shoulder width	27.70	26.92	$P<0.01$
Rump width	25.48	25.76	n.s.
Body length	74.59	80.48	$P<0.01$
Chest girth	121.88	121.03	n.s.

Table 6
Carcass traits[a]

		Indoor	Outdoor	Significance	RSD
Carcass length	cm	73.21	76.37	$P<0.01$	3.437
Chest deep	cm	20.05	19.94	n.s.	1.524
Backfat thickness					
1° thoracic vertebra					
outer layer	mm	18.29	17.43	n.s.	4.553
inner layer	mm	37.22	31.70	$P<0.01$	6.06
total	mm	55.51	49.13	$P<0.01$	7.129
Backfat thickness					
last thoracic vertebra					
outer layer	mm	16.18	14.55	n.s.	3.034
inner layer	mm	20.81	17.91	$P=0.06$	4.948
total	mm	36.99	32.46	$P=0.02$	6.052
Backfat thickness					
Gluteus medius					
outer layer	mm	26.39	21.5	$P<0.01$	5.071
inner layer	mm	18.15	17.85	n.s.	4.373
total	mm	44.54	39.44	$P=0.03$	7.610

[a] Means estimated at average carcass weight of 77.85 kg

Table 7
Dressing and carcass composition percentages[a]

	Indoor	Outdoor	Significance	RSD
Dressing	82.51	81.86	n.s.	2.2
Loin	13.4	13.07	n.s.	1.297
Ham	21.07	22.38	$P<0.01$	1.377
Shoulder	12.48	13.03	$P<0.01$	0.715
Neck	6.80	6.86	n.s.	0.687
Lean cuts	53.84	55.48	$P=0.08$	3.058
Backfat	15.17	13.06	$P<0.01$	2.188
Belly	13.12	12.73	n.s.	1.226
Jowl	6.65	6.90	n.s.	0.876
Kidney fat	3.83	4.89	$P<0.01$	1.218
Fat cuts	39.42	37.74	n.s.	3.487
Head	4.97	4.93	n.s.	0.564
Feet	1.66	1.84	$P<0.01$	0.256
Bone cuts	6.62	6.77	n.s.	0.716

[a] Means estimated at average carcass weight of 77.85 kg

showed a higher percentage of fat cuts (Franci et al., 2001; Acciaioli et al., 2002). However, Cinta Senese pigs were slaughtered at live weights greater than those in this trial. Carcass composition of local pigs seemed to be influenced by the weight/age ratio which is related to the rearing system (Franci, Pugliese, Bozzi, Acciaioli, Campodoni, & Gandini, 2000).

Sex did not significantly affect any of the analysed parameters except width at shoulders (27.08 cm in males and 27.58 cm in females at 100 kg body weight), percentage of ham (22.11 in males and 21.33% in females) and kidney fat (3.98 males and 4.74% in females). Sex effects were probably reduced by castration of both males and females, as reported by Mayoral et al. (1999) for castrated male and female Iberian pigs.

4. Conclusions

The slower growth rate of outdoor versus indoor pigs affected their body dimensions. At the same age, outdoor pigs were smaller than indoor animals. Moreover, the allometric study showed that, at the same live weight, because of their older ages, the outdoor pigs had greater skeletal development, confirming that this is more related to age than body weight. The rearing system also affected carcass characteristics. Outdoor pigs were leaner, mainly because of higher shoulder and ham development. Taking the performances of pigs in the indoor system as the potential of the breed, this study shows that the traditional free-range system could be improved by providing feed integration during the critical periods of low wood productivity. The optimisation of traditional farming should increase the economic profitability of the breed, thus removing the danger of its decline. However, the optimisation process should retain the specific values of the traditional farming, including its social role, the favourable interactions with landscape and woods management, the associated cultural values and the characteristics of the typical meat products traditionally linked to this breed.

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