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Productivity of Cinta Senese and Large White x Cinta Senese pigs reared outdoors in woodlands and indoors. 2. Slaughter and carcass traits

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ABSTRACT

The aim of this paper was to study slaughter and carcass traits of Cinta Senese pigs, both pure and crossbred with Large White, reared outdoors in woodland and indoors. Sixteen Cinta Senese (CS) and 16 Large White x Cinta Senese (LWxCS) pigs were reared outdoors (OUT) on woodland pastures with some food supplementation; 70 animals (29 CS, 29 LWxCS and 12 LW) were reared indoors (IN), allotted in pens for genetic type and sex. Pigs were slaughtered at about 140 kg of live weight and at an age greater than 8 months. After slaughter, carcass length, thorax depth, number of vertebrae and backfat thickness were measured, and carcasses were dissected into lean, fat and bone cuts. Average daily gain to slaughter differed markedly among the five GTxRS combinations (598; 512; 438; 338; 250 g/d, respectively for LW-IN; LWxCS-IN; CS-IN; LWxCS-OUT; CS-OUT). LWxCS-IN and LWxCS-OUT had respectively the highest and the lowest dressing percentages (83.3% and 80.1%). A greater compactness of CS carcasses was evident from the length to depth ratio. In both farming systems CS pigs had the thickest backfat, and their differences with the other genetic types increased proportionally according to a cranio-caudal gradient. Moreover, CS pigs showed lower percentage of lean cuts and a higher percentage of fat cuts, than the other breeds. In the indoor system an additive effect was evident, with crossbred pigs showing lean cuts yields (62.8%) of almost intermediate value with respect to the parental breeds (57.7% for CS and 69.1% for LW). Some effects of the availability of woodland pastures on growth and carcass composition were also observed, particularly showing CS-OUT pigs' higher percentage of backfat and kidney fat, and lower percentage of loin and shoulder than the CS-IN ones.

Key words: Cinta Senese, Pig, Outdoor, Carcass traits, Carcass composition.

RIASSUNTO

PRODUTTIVITÀ DI SUINI CINTA SENESE E METICCI CINTA SENESE X LARGE WHITE ALLEVATI AL PASCOLO IN BOSCO E IN STABULAZIONE. 2. CARATTERISTICHE ALLA MACELLAZIONE E DELLA CARCASSA

Ventinove suini Cinta Senese (CS), 12 Large White (LW) e 29 meticci LWxCS sono stati allevati in stalletti (indoor - IN) suddivisi per tipo genetico e sesso e alimentati "ad appetito" con miscele commerciali. Sedici suini CS e 16 meticci LWxCS, coetanei ai precedenti, sono stati allevati al brado (outdoor - OUT) in territorio boschivo (Quercus ilex, Castanea sativa) con minima integrazione alimentare effettuata con le stesse miscele dell'allevamento indoor. In entrambi i sistemi, tanto i maschi che le femmine sono stati castrati. Alla macellazione, avvenuta ad un peso di circa 140 kg e comunque ad un'età superiore a 8 mesi, sono state rilevati lo spessore degli strati superficiale e profondo del grasso dorsale a

tre localizzazioni (prima e ultima vertebra toracica – FT e LT – e gluteus medius – GM), la lunghezza della carcassa e la profondità del torace. La mezzena destra è stata scomposta nei singoli tagli magri, grassi ed ossei. L'analisi statistica ha considerato come effetti fissi la combinazione tipo genetico x sistema di allevamento (5 gruppi) ed il sesso oltre che la covariata peso vivo entro gruppo.

L'incremento medio giornaliero fino alla macellazione è stato molto differente fra i gruppi (598; 512; 438; 338; 250 g/d rispettivamente per LW-IN; LWxCS-IN; CS-IN; LWxCS-OUT; CS-OUT) e conseguentemente sono stati differenti anche l'età alla macellazione e, in qualche misura, il peso. LWxCS-IN e LWxCS-OUT hanno avuto rispettivamente la resa al macello più alta e più bassa (83,3% e 80,1%). La Cinta Senese ha presentato carcasse più compatte (minor valore del rapporto lunghezza/profondità) degli altri genotipi, entro sistema di allevamento. Comunque allevati, i suini CS hanno esibito maggior spessore del grasso dorsale rispetto agli altri genotipi, con un incremento delle differenze relative procedendo dalla localizzazione craniale (FT) a quella caudale (GM). Il lardo dei CS-OUT, tuttavia, è risultato più spesso a FT e più sottile a LT e GM rispetto a quello dei CS-IN.

La maggiore adiposità dei CS rispetto agli altri tipi genetici è stata confermata alla dissezione della mezzena. Per i suini allevati indoor è risultata evidente l'additività dell'effetto genetico poiché l'incrocio ha presentato valori di incidenza dei vari tagli generalmente intermedi rispetto alle razze parentali (es. tagli magri totali 57,7%; 62,8%; 69,1% rispettivamente per CS; LWxCS; LW). Il sistema di allevamento ha influito sulla composizione della carcassa i entrambi i genotipi testati. Rispetto ai CS-IN, i suini CS-OUT hanno avuto maggiore incidenza dei tagli grassi, in particolare del lardo e del grasso perirenale, e minore proporzione di lombata e spalla.

La composizione della carcassa è stata solo marginalmente influenzata dall'effetto sesso, probabilmente a causa della castrazione effettuata su tutti i soggetti.

Parole chiave*: Cinta Senese, Suino, Allevamento estensivo, Caratteristiche della carcassa, Composizione della mezzena.*

Introduction

After the severe bottleneck in the eighties when it numbered a only few dozen animals, the Cinta Senese pig today seems to have recovered a significant market linked to the typicality and authenticity of its products, both fresh and seasoned. Traditionally, this breed was reared under extensive or semi extensive management with the utilization of woodland feed resources, such as chestnuts and acorns, both pure-bred and, from the second half of the last century, crossed with Large White boars. The renewed interest in the breed, both from farmers and the local administration, together with its current rapid demographic growth, requires a better understanding of the breed potential under different management systems.

Rearing and feeding systems have strong influence on carcass and meat quality and this aspect needs to be investigated with specific experimental approaches. Recent studies on some European local pig breeds (Legault *et al.*, 1996; Serra *et al.*, 1998; Mayoral *et al.*, 1999;Labroue *et al.*, 2000) investigated the effects of production systems on their performances. Research on the Cinta Senese (Salerno, 1953; Raimondi, 1955; Magliano and Jannella, 1956;) dates back to the fifties, when the breed was one of the most promising Italian local breeds. In those years the Cinta Senese showed good overall characteristics, but a lower dressing percentage, lower lean cuts yield and a higher incidence of backfat when compared to York crosses and other improved genetic types. More recent investigations on Cinta Senese x Large White crosses showed that such genotype produces fat of excellent technological quality but lean cuts yields lower than those of the improved breed (Franci *et al.*, 1994b).

This paper reports on slaughter and carcass traits of Cinta Senese pigs, both pure and crossbred with Large White, reared under two farming systems: outdoors in woodland and indoors. Previous reports analyzed reproductive traits (Franci *et al.*, 1998) and growth performance (Acciaioli *et al.*, 2002) of the same animals.

Material and methods

Animals were raised on two farms corresponding to two different farming systems: i) outdoors on woodland pastures with some food supplementation and ii) in indoor pens for the entire fattening period. Rearing systems and feeding regimes are described elsewhere (Acciaioli *et al.*, 2002).

A total of 102 animals were used. Both males and females were castrated at three weeks of age. Sixteen Cinta Senese (CS) and 16 Large White x Cinta Senese (LWxCS) pigs were reared outdoors; 70 animals (29 CS, 29 LWxCS and 12 LW) were reared indoors distributed in 12 pens, allotted for genetic type and sex. LW pigs were reared only indoors and used as control animals.

Pigs were slaughtered at about 140 kg of live weight and at an age greater than 8 months. After slaughter the following measures were taken on the right side: carcass length, thorax depth, number of thoracic and lumbar vertebrae, backfat thickness (separately for inner and outer layers) at the first (FT) and the last (LT) thoracic vertebra, and at the *Gluteus medius* muscle (GM). The right side was dissected following ASPA methodology (ASPA, 1991). Lean cuts (loin, ham with foot, shoulder with foot, neck), fat cuts (backfat, belly, jowl, kidney and pelvic fat) and bone cuts (head) were weighed.

Data analysis was carried out with the SAS software package (1996), considering sex and 'genetic type x rearing system' (GTxRS, 5 levels) as fixed effects. For carcass traits, the model also considered, as infraclass covariate, the difference between the individual live weight and the average live weight of the relative GTxRS group. This model made it possible to reduce the residual variance and to estimate means at the average live weight of each group. An alternative model with live weight as covariate would make it possible to obtain the estimates at the overall mean of live weight for the 5 groups, but it was inapplicable because of the lack of overlap of weight ranges among some groups. Then, results on carcass traits refer to the different live weights and ages at slaughter relative to the tested genotypes and rearing systems.

Results and discussion

Productive performance

Table 1 reports age and body weight at slaughter, average daily gain from birth to slaughter and dressing percentage. ADG differed markedly among the five GTxRS combinations. The effect of the genetic type within each rearing system is evident, with the lowest performance of the CS breed compared to LWxCS and LW. In the indoor system, there is an evident additive genetic effect with the crossbred pigs showing an ADG corresponding to the average value of the parental breeds. The lower growth rate of the unimproved breed confirms the results found in other European autochthonous breeds by Legault *et al.* (1996) and Serra *et al.* (1998). Within genotype, the outdoor system produced a significant reduction of weight gain compared to the indoor one: by 57% and 66% in CS and LWxCS pigs, respectively. Such result is in agreement with the findings of Enfält *et al.* (1997) on improved breeds, and of Legault *et al.* (1996) on two autochthonous French breeds, Limousin and Gascon. An analysis of weight-age relationship in these animals has been reported in a previous

Table 1. Age, live weight at slaughter, average daily gain from birth to slaughter and dressing percentage of the animals.

		Genotype x rearing system					Sex[1]		rsd
		Outdoor		Indoor					
		CS[2]	LWxCS	CS	LWxCS	LW	Male	Female	
Age	d	509.7a	425.8b	311.5c	272.4d	259.4e	356.2	355.4	16.02
Live weight	kg	127.6d	144.1b	136.0c	138.8c	154.9a	142.3a	138.3b	8.42
LW range	"	114-138	123-173	119-153	125-152	144-176			
Daily gain	g	250a	338b	438c	512d	598e	433	421	32.8
Dressing percentage		81.52b	80.07c	81.17b	83.26a	82.95a	81.03a	82.52b	1.71

[1] Both sexes were castrated;
[2] CS = Cinta Senese; LW = Large White;
a, b, c. within criterion means different (P<0.05);

work (Acciaioli *et al.*, 2002) where the different growth patterns of the five groups are discussed.

As consequence of the different growth rates, the five groups reached the target slaughter weight at very different ages and, moreover, some differences in slaughter weight has been recognized, particularly for the extreme values of LW-indoor and CS-outdoor groups. The rearing system markedly influenced dressing percentage in the crossbred pigs, which showed the highest yield when reared indoors, although statistically not different from LW pigs, and the lowest when reared outdoors. It is known that dressing percentage is positively influenced by fatness also in the rustic pig breeds (Legault *et al.*, 1996; Serra *et al.*, 1998; Labroue *et al.*, 2000;). Then, our result could be ascribed to the moderate fatness of the outdoor LWxCS pigs (Table 3) that reached the target weight of 140 kg at the beginning of autumn, before the availability of acorns, and so were penalised in the fat deposition. On the contrary, the rearing system did not influence dressing percentage in the Cinta Senese pigs. Comparisons involving Cinta Senese and other breeds are scarce in literature, but Franci *et al.* (1994a) found some differences in dressing percentage between LW (78.2%) and CSxLW (79.7%) reared in pens, in contrast with the present results. Investigations carried out in the fifties found dressing percentages of 79.7% (Raimondi, 1955) and 78.3% (Magliano and Jannella, 1956) for LWxCS pigs, and of 82.5% for Cinta Senese pigs (Salerno, 1953), but comparisons are difficult because of the differences in experimental methodologies. A gender difference was found in our trial for dressing percentage, which was higher in females than in males.

Carcass measurements

Table 2 reports carcass measures. LW-indoor and LWxCS-outdoor groups showed the longest carcasses but the result is also influenced by differences in body weight, obviously. However, the finding is in agreement with what by Acciaioli *et al.* (2002) related *in vivo* for body length, at the same weight. Using a statistical analysis which considered only genetic type (the 3 genotypes) and sex as effects, it emerged that the total number of vertebrae (data not tabulated) did not differ

Table 2. Carcass measurements

		Genotype x rearing system					Sex[1]		rsd
		Outdoor		Indoor					
		CS[2]	LWxCS	CS	LWxCS	LW	Male	Female	
Length	mm	815 d	889 ab	852 c	876 b	906 a	865	871	24.8
Thorax dept	"	214 a	213 a	213 a	205 b	204 b	209	211	12.1
Length/dept		3.81 a	4.18 c	4.01 b	4.29 cd	4.47 d	4.17	4.14	0.27
Backfat thickness(mm):									
FT total		64.7 a	47.8 d	57.8 b	51.5 c	47.3 d	53.5	54.2	5.5
FT outer layer		18.7 a	15.6 b	18.8 a	16.0 b	16.1 b	16.9	17.1	3.7
FT inner layer		46.0 a	32.1 d	39.1 b	35.4 c	31.2 d	36.5	37.1	4.0
LT total		36.7 b	24.5 d	40.0 a	32.3 c	29.9 c	32.1	33.3	4.7
LT outer layer		12.8 b	10.4 c	15.4 a	11.3 bc	9.1 c	11.4	12.2	3.2
LT inner layer		24.0 a	14.1 c	24.6 a	21.0 b	20.8 b	20.7	21.1	3.1
GM total		45.8 b	22.6 d	49.2 a	38.8 c	26.1 d	36.0	37.1	5.1
GM outer layer		20.1 b	11.3 d	25.5 a	18.4 b	14.5 c	18.2	17.8	4.1
GM inner layer		25.7 a	11.3 c	23.7 a	20.4 b	11.6 c	17.8 b	19.3 a	3.4

1 Both sexes were castrated;
2 CS = Cinta Senese; LW = Large White;
a, b, c. within criterion means different (P<0.05);
FT = at first thoracic vertebra; LT = at last thoracic vertebra; GM = at gluteus medius

among genetic types even if the CS breed showed the highest number of lumbar vertebrae (6.7; 6.5; 6.3; for CS, LWxCS and LW, respectively) and the LW breed showed the highest number of thoracic vertebrae (14.0; 13.8; 14.2; for CS, LWxCS and LW, respectively). Thus, the unselected Cinta Senese has the classical vertebral formulae of Sus scrofa, and differs from Sus scrofa ferus characterized by 5 lumbar vertebrae (Renieri *et al.*, 1989).

Despite the lower body weight, thoracic depth was significantly higher in the Cinta Senese than in the other genetic types, especially for indoor animals. The greater compactness of Cinta Senese carcasses was also evident from the length to depth ratio, which partially corrects the bias due to the different weights. Acciaioli *et al.* (2002) obtained similar result by analyzing *in vivo* morphological development of the same animals by means of an allometric function, putting in evidence the typical conformation of this rustic animal with greater development of the fore part of body, the chest in particular.

Interpretation of results on backfat thickness is more complex but a genetic influence is evident within both rearing systems. CS pigs showed the thickest backfat and the differences with the other genetic types increased proportionally according to a cranio-caudal gradient, as observed by Franci *et al.* (1994a) between LW and CSxLW pigs. The higher fatness of Cinta Senese pigs confirms the strong adipogenetic ability of the unimproved breeds (Labroue *et al.*, 2000). It should be noted that the highest thickness of backfat in CS can be ascribed to a great extent to the inner layer, particularly in the most anterior location. This layer is late developing, as observed by Geri *et al.* (1986), thus it is more sensitive to feed availability in the last period of fattening. Crossbred pigs reared indoors showed intermediate values with respect to parental breeds, whereas LWxCS-outdoor pigs were similar to LW because of the aforementioned feeding conditions. The effect of rearing system is evident within genetic type. In particular, CS pigs reared outdoors showed higher thickness at FT and lower at LT and at GM when compared to the indoor ones. Thus it seems that an uninterrupted feed availability, as expected under intensive management, and the consequent younger age at slaughter, determined a more homogeneous distribution of the fat along the back, whereas a discontinuous feeding with a final forcing favoured fat deposition at the level of the anterior regions of body, which are late developing.

Carcass composition

Table 3 reports the carcass composition. Genetic influence was evident. CS breed, in both systems, showed lower percentages of total and individual lean cuts than the other genotypes, within the rearing system. Moreover, in the indoor system, crossbred pigs had lean cuts yields of almost intermediate value with respect to the parental breeds. The results of the comparison between LW and crosses are in accordance with those reported by Franci *et al.* (1994b) where the LW was used as maternal base in crosses. Results for fat cuts percentage were, obviously, complementary to those of lean cuts, with the CS breed showing the fattest carcasses. Differences were particularly marked for backfat and kidney fat. Some differences were observed for bone cut (head) incidence, but not a clear ranking among genetic types and rearing systems was detected.

The results obtained in the indoor system, where the genetic potential can be better expressed, highlight the greater fleshiness of the carcass of the improved breed, especially for the high-price cuts such as ham and loin, and provide an estimate of the genetic improvement obtained in swine for carcass quality. The fatness of carcass, measured as loin+neck to backfat ratio, was about twice as great in LW (3.73) as in CS (1.88); similar relative values, (setting aside differences due to cutting method) were found by Legault *et al.* (1996) on autochthonous French breeds and improved crosses (LWxLandrace 3.05; Gascon 1.47; Limousin 1.44). Moreover, the loin/neck and ham/shoulder ratios demonstrate the difference in morphology between the unimproved and improved breeds. The first ratio showed greater development of the fore cuts along the vertebral column in CS than in LW, while the ham/shoulder ratio showed an opposite trend (though not significant) with a greater equilibrium between fore and hind limb in the improved breed, confirming the effects of the recent selection that tends to approach the "modern" swine to the "four hams" type.

Rearing system also affected carcass composition, but in an opposite way in CS and LWxCS, possibly because of the different feeding regimen of the LWxCS-outdoor pigs that limited their fatness, as mentioned above and discussed in a previous report (Acciaioli *et al.*, 2002). For the CS breed, for which the traditional extensive system of fattening on acorn was adopted, the higher fatness of carcasses of the outdoor pigs with respect to the indoor ones is evident. CS-outdoor pigs were particularly penalized in the loin and shoulder proportions and, contrarily, showed higher percentages of backfat and kidney fat, not entirely balanced within fat cuts by the lower percentages of belly and jowl. In CS pigs the free-range rearing system and the consequent fattening on acorns favored fat deposition, particularly in the internal and dorsal subcutaneous depots. Moreover, as the loin/neck and ham/shoulder ratios indicated, the outdoor rearing favored the development of the fore cuts along the vertebral column and of the hind limb on the forelimb.

Sex did not significantly influence any carcass traits (Table 2 and 3) except for the backfat thickness of the inner layer at GM and the percentage of neck (higher in males) and of belly (higher in females). Sex effect was probably reduced by the castration of both males and females, in accordance with the results of Mayoral *et al.* (1999) that did not observe any sex effect on carcass traits of Iberian castrated pigs.

Conclusions

The results obtained in the indoor management system, where the genetic potential can be better expressed, made it possible to characterize, for the carcass traits, the Cinta Senese in comparison to both the improved breed and the relative crosses. With respect to the Large White, the local breed showed about 11 percentage points more of fat cuts and a correspondent loss of lean cuts, which suggests the opportunity to find a suitable commercial utilization of fat cuts, and in particular backfat, in the Cinta Senese pig. The performance of the crossed pigs, that were intermediate between parental genotypes, confirms the theory according to which additive genetic effects, also in pigs, mainly control morphology and body composition. This trial showed that crossbreeding increases Cinta

Table 3. Half carcass composition.

		Genotype x rearing system					Sex[1]		rsd
		Outdoor		Indoor					
		CS[2]	LWxCS	CS	LWxCS	LW	Male	Female	
Lean cuts	%	54.07 d	67.63 a	57.70 c	62.76 b	69.06 a	62.42	62.07	1.88
- Ham	"	22.77 c	25.06 b	22.49 c	24.62 b	26.44 a	24.16	24.39	0.85
- Loin	"	13.44 d	19.25 a	15.20 c	16.61 b	19.25 a	16.70	16.80	1.21
- Shoulder	"	12.08 d	16.88 a	14.05 c	15.72 b	17.04 a	15.31	15.00	0.75
- Neck	"	5.77 b	6.45 a	5.97 b	5.82 b	6.34 a	6.25 a	5.90 b	0.50
Fat cuts	"	40.97 a	26.96 d	37.15 b	32.41 c	26.02 d	32.51	32.90	2.05
- Belly	"	13.23 b	12.15 c	14.70 a	13.70 b	11.70 c	12.86 a	13.33 b	0.97
- Backfat	"	17.56 a	5.44 e	11.26 b	9.01 c	6.84 d	9.96	10.08	1.48
- Jowl	"	5.81 d	6.68 b	7.25 a	6.22 c	5.53 d	6.41	6.19	0.62
- Kidney fat	"	4.37 a	2.68 d	3.93 b	3.50 c	1.95 e	3.28	3.30	0.52
Head	"	4.96 ab	5.41 c	5.14 bc	4.82 a	4.92 ab	5.07	5.02	0.46
Loin/Neck		2.35 c	3.00 a	2.57 b	2.86 a	3.05 a	2.68 a	2.85 b	0.29
Ham/Shoulder		1.89 a	1.49 c	1.60 b	1.57 b	1.55 b c	1.59 a	1.65 b	0.99

1 Both sexes were castrated;
2 CS = Cinta Senese; LW = Large White;
a, b, c. within criterion means different (P<0.05);

Senese performances. However, considering the endangered status of the breed, crossbreeding should be developed within a precise breed conservation strategy. The outdoor management system, besides the difficulties encountered for a direct parallel comparison of different genotypes, pointed out the necessity of an accurate temporal planning of farrowing in relation to acorn availability in the fattening period. The limited feed supplementation offered in the outdoor system in this trial provoked a consistent lengthening of the growth period. Moreover, the autumn woodland pastures for Cinta Senese pigs resulted in a carcass composition richer in fat tissue when compared to the indoor ones. Finally, to obtain a more complete characterization of the farming of the Cinta Senese under different management conditions, future research is also needed on meat and fat quality.

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