

PAPER

Slaughtering traits and meat quality of Cinisara cattle, a native Italian breed

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Abstract

The aim of our study was to make an initial contribution to carcass traits and meat quality for typing and product certification, using sixteen male (M) and twelve female (F) Cinisara cattle, a native Italian breed. The animals were sampled in the most representative farms of the *Consortium of Cinisara breed*. Carcass traits of the Cinisara males showed significantly higher carcass weight and SEUROP scores in comparison to the females, while similar values were observed for fatness scores. As regards meat quality, lightness (M 44.90 vs F 43.25), redness index (M 18.03 vs F 17.86), hue angle (M 21.71 vs F 23.76), cooking losses (M 24.44% vs F 24.98%), tenderness (M 3.36 kg/cm² vs F 3.41 kg/cm²), protein (M 22.58% vs F 21.84%) and fat (M 1.88% vs F 2.63%) showed no significant differences between males and females. No data are available in the literature for Cinisara cattle; therefore, our results may be considered as an original set of knowledge useful for the salvage of this endangered, local, native breed.

Introduction

In some European areas, the use of local breeds produced under traditional breeding systems and following quality trademark regulations could be an interesting alternative for the exploitation of typical high-quality products, linked to place of origin, and for the ecologically sustainable economy of local production systems (Ciotola *et al.*, 2009). However, producers and retailers often lack the necessary objective information to promote and make good use of the quality of the products obtained from these breeds, in order to achieve product differentiation. In the case of Italy,

among the various rustic breeds, Cinisara cattle are a local, native breed belonging to the group of the Podoliche breeds. It has its origin in many different areas of the Palermo province: Cinisi (from which it takes its name), Carini, Terrasini, Torretta, Capaci, Montelepre, etc. Few animals are reared in the highlands of the Trapani, Messina and Enna provinces (Liotta and Chiofalo, 2007). This cattle population, thanks to the natural adaptation to harsh environment and climates, is able to use poor quality feeds and to cope with endemic diseases (Rischkowsky and Pilling, 2007). Moreover, Cinisara cattle are characterised by an instinctive grazing ability on marginal sloped pastures and, therefore, they are well adapted to the difficult environmental conditions of the northwestern area of Sicily. The environmental conditions and the genetic programmes have determined, over time, the differentiation of Cinisara cattle as a Sicilian ecotype. Today, the population size of this breed of cattle is about 5800 animals: 4900 females and 900 males (BDN, 2010). They are characterised by a size of 140-150 cm and 130-140 cm, respectively, for males and females (Giaccone *et al.*, 1988), a skeletal structure very robust and a black, uniform coat; the *agghio* coat, that is, black with a white band on the head, dorsal line, perineum, tail and ventral line. Since 1975, the starting date of the milk yield and production checks, until 1995, the Cinisara cattle breed was included in the Modicana cattle native breeds Register. In 1995, by a Decree of the Ministry of Agriculture, Food and Forest Resources (MiPAFF), Cinisara cattle have been officially recognised as a breed, with the establishment of the native breeds Register of the indigenous population of cattle and of the ethnic groups with limited distribution. In relation to the restriction imposed by the EU on the production of dairy cattle, Sicilian farmers have shown a growing interest in the use of this indigenous breed for meat production. This enables the conservation of this native cattle breed, which not only safeguards the biodiversity but also gives significant environmental protection.

In 2005, in order to protect the Cinisara cattle and breeding system within the area of origin and to enhance its meat production characteristic, the *Consortium of Cinisara breed* was established, and in 2006 there was a request for PDO (Protected Designation of Origin) recognition under the name of *Carne Bovina Cinisara*. The objective of our study was to present an initial contribution on carcass traits and meat quality of Cinisara cattle for typing and product certification.

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Materials and methods

Animals and diet

The study was carried out on a total of twenty-eight pure Cinisara cattle, bred under the traditional production system on four farms located in the Palermo province, which were the most representative of the *Consortium of Cinisara breed*. In each farm, four males and three females were randomly selected from larger groups of animals. The calves were reared with their dams until natural weaning, at approximately 10 months of age, on the natural pasture of Northwest Sicily (Italy), where no feeding supplementation was offered. After weaning and until slaughter, the calves were fed the same diet, based on concentrate and meadow hay offered *ad libitum*. The ingredients and the chemical composition of the feeds (AOAC, 2007) are reported in Table 1. The facilities comprised two different parts: an indoor area with straw bedding on a concrete floor and an adjacent open area (ground exercise yard).

Slaughtering and sampling

Taking local market preferences into account, slaughtering was done according to a finishing grade, with an age range of 18-30 months. The finishing grade was evaluated subjectively by experienced assessors according to the quality trademark. Twenty-eight carcasses of male (16) and female (12) Cinisara cattle, slaughtered from August to December 2009 at an age of 23 months for males and 27 months for females, were used. The animals were weighed just before slaughtering in an authorised, commercial, EU-licensed abattoir, following the recommendations of the European Council (1986) concerning animal care. At the abattoir, the animals were deprived of feed overnight, but water was always available. One week (± 2 days) after slaughtering, according to the usual commercial ageing period for Cinisara meat, the right side was quartered and the hind quarter was dissected into deboned and trimmed commercial joints, following the local butchering procedure. To evaluate the meat quality characteristics, the *longissimus thoracis* muscle between the seventh and eighth ribs was removed and used for the analyses (ASPA, 1996).

Slaughter performance

At 24 h postmortem, carcasses (including testicles, but not kidney, pelvic fat and tail) were weighed; on the one side of the cold carcasses, various linear measurements were taken to determine carcass conformation: internal length (from the lumbosacral joint to the cervicothoracic joint), depth (from the dorsal to the ventral edges of the carcass side along the sixth rib), hind leg length (from the ridge of the distal end of the tibia to the cut edge of the subcutaneous fat along a line joining to the anterior pubic symphysis) were measured, using a computerised system of image analysis (Image-Pro[®] Plus, Version 5.0) and a digital camera. Carcass compactness index (cold carcass weight/internal carcass length) and lateral conformation (carcass depth/internal carcass length $\times 100$) were determined (Spanghero *et al.*, 2004). The carcasses were classified for conformation (12 classes: S, E, U, R+, R, R-, O+, O- and P+, P, P-; class 1 for P- and class 12 for S conformation) and fat cover (5 classes: 1, 2, 3, 4 and 5) using the SEUROP quality classification (European Council, 1991).

Physical and chemical analyses

At seven days after slaughter, the pH of the *longissimus thoracis* muscles was determined using a WTW 330/SET 1 (Weilheim, Germany)

pH-meter provided with a Hamilton double-pore glass-piercing electrode and an automatic temperature compensator. The colour was measured on a 2.5-cm-thick slice of meat, using the CIE system (Commission International d'Eclairage, 1978) colour profile for lightness (L^*), redness (a^*), and yellowness (b^*) and a desktop photometer (Spectral scanner, DV Technologie d'Avanguardia, Padova, Italy), calibrated against a standard white tile with an illuminant source D65. Prior to colour evaluation, each sample was allowed to oxygenate at 4°C for 45 min, covered with an oxygen permeable polyethylene film. After removing the polyethylene film, the meat colour was determined on one reading for the whole slice of each sample. Chroma (C^*) and hue (H^*) were calculated according to the following formulae (ASPA, 1996):

$$\text{Chroma} = (a^2 + b^2)^{1/2}$$

$$\text{Hue} = \tan^{-1}(b/a)$$

Cooking losses were determined on the samples, each 190g on average, cooked by immersing the individual bags in a 95°C water bath (WB-OD24, FALC Instruments, Italy) for several minutes until the internal temperature reached 75°C; the sample temperature was detected using a thermocouple thermometer AMA-DIGIT (Buddeberg GmbH, Germany).

After cooking, the bags were tempered at room temperature before opening to drain the liquid. Cooking loss was calculated using the formula:

$$[(\text{weight of raw meat} - \text{weight of cooked meat}) / \text{weight of raw meat}] \times 100.$$

Tenderness of the cooked sample was measured as a shear force, using a Warner-Bratzler (WBSF) cell mounted on an Instron 5542 (Instron, High Wycombe, UK) universal testing machine. The measurement was recorded as the peak yield force in kg/cm², required to shear, at a 200 mm/min crosshead speed, perpendicularly to the direction of the fibres, three cylindrical cross-section (10 mm diameter and 25 mm length) replicates from each sample (ASPA, 1996). Moisture, fat, protein, collagen and salt content in each sample were determined, according to AOAC methods (method number is 2007-04), using Near Infrared Spectroscopy in Transmittance (FoodScan[™] Meat Analyser; FOSS, Italy).

Statistical analysis

Statistical analysis of carcass traits and meat quality was performed using a one-way analysis of covariance (male *vs* female), with the age of animals as the covariate, by the GLM procedure of SAS (2001).

Table 1. Proportion of ingredients and chemical composition of the concentrate mixture and meadow hay used during the trial.

	Concentrate mixture	Feeds	Meadow hay
Ingredients, g/kg DM			
Maize meal	450	-	-
Barley meal	140	-	-
Wheat bran	110	-	-
Peas bean	110	-	-
Soybean meal 44% CP	110	-	-
Carob	40	-	-
Calcium soaps	15	-	-
Calcium carbonate	8.5	-	-
Sodium bicarbonate	6.0	-	-
Sodium chloride	3.0	-	-
Dicalcium phosphate	3.0	-	-
Magnesium sulphate	2.0	-	-
Vitamin-mineral premix ^o	2.5	-	-
Chemical composition			
Dry matter, g/kg	895.30		870.00
Crude protein, g/kg DM	166.20		100.00
Ether extract, g/kg DM	49.40		32.00
Crude fibre, g/kg DM	54.30		260.00
Ash, g/kg DM	46.80		70.20
Neutral detergent fibre, g/kg DM	136.20		450.00
Unité Fouragère Viande/kg DM	1.17		0.59

^oVitamin and mineral premix composition (/kg of concentrate mixture): vitamin A, 20,000 U; vitamin D₃, 4000 U; alpha-tocopherol, 75 mg; vitamin B₁, 12.5 mg; vitamin B₂, 7.5 mg; vitamin B₆, 3 mg; pantothenic acid, 10 mg; vitamin PP, 100 mg; Zn, 150 mg; Fe, 100 mg; Mn, 60 mg; Cu, 6 mg.

Results and discussion

Slaughter performances

Results obtained for slaughter performance are consistent with the findings of other authors who have worked with breeds not specialised in meat production such as Friesians, crossbreeds (Charolais x Friesians) (Keane *et al.*, 1990), rustic genotype (Morucha) and another crossbreed (Charolais x Morucha) (Vieira *et al.*, 2006). At the abattoir, the carcass traits of Cinisara males showed the significantly higher carcass weight and SEUROP scores, in comparison to the females, while similar values were observed for fatness scores (Table 2). Carcass measurement confirmed the body shape diversity between sexes, males having significantly shorter carcass depth than females, and, as a consequence, a significantly lower lateral conformation was observed (Table 2).

Physical characteristics of meat

The pH at seven days after slaughtering (Table 3) was comparable in the two sexes and was within the normal commercial range (Spanghero *et al.*, 2004). The physical characteristics of meat did not show any significant difference between the sexes (Table 3).

Cinisara meat showed a slightly higher lightness than the meat of other specialised breeds (Charolaise: 44; Limousine: 42.9) and crossbreeds (Charolaise x Siciliana: 42.9; Limousine x Siciliana: 42.4; Belgian Blue x Siciliana: 42) reared in Sicily, as observed by Chiofalo *et al.* (2004). On the contrary, the lightness value was similar to that observed by D'Agata *et al.* (2005) in the *longissimus dorsi* muscle of Chianina steers (40.87), reared under traditional systems and commercialised under the labels of designation of origin *Vitellone Bianco dell'Appennino Centrale* (i.e. protected geographical indication, PGI).

The values of redness (a*) observed in the Cinisara breed might be owing to the high myoglobin content observed in the *longissimus thoracis* muscle of rustic breeds (Viera *et al.*, 2006). Hue angle, which in meat samples is correlated to the relative percentage of yellow and red colours, was lower in the Cinisara breed (21.71) than Morucha breed (34.2) and crossbreed Charolaise x Morucha (36.5) (Viera *et al.*, 2006). The cooking losses (Table 3), both in males and females, showed lower values than those observed previously in meat belonging to crossbreed Limousine x Siciliana, in Sicily (27.34) (Furfaro *et al.*, 2005). The WBSF was very low (Table 3), according to the

observations of Chiofalo *et al.* (2004) in the *longissimus dorsi* muscle of specialised breeds (Charolaise: 3.6 kg/cm²; Limousine: 3.9 kg/cm²) and crossbreeds (Charolaise x Siciliana: 4.3 kg/cm²; Limousine x Siciliana: 4.1 kg/cm²; Belgian Blue x Siciliana: 3.9 kg/cm²), in Sicily, and by Mele *et al.* (2008) on young Maremmana bulls (2.20 kg/cm²) and steers (2.82 kg/cm²). Cinisara meat was more tender (Table 3) than that observed by Silva *et al.* (1999) in the *longissimus thoracis* muscle of Portuguese autochthonous Maronesa bulls (11.6 kg/cm²), at seven days postmortem. Therefore, recent studies (Monsón *et al.*, 2005; Stolorowski *et al.*, 2006) suggested that genetic differences in beef tenderness are associated

with variations in the rate and extent of muscle proteolysis that occur during postmortem storage of fresh meat.

Chemical characteristics of meat

No effect of sex was recorded on any of the chemical characteristics of meat, although the females tended to have a higher content of intramuscular fat, collagen and salt (Table 4). This could be related to the large variability of the slaughter age in the males (699±166 days) as well as in the females (827±177 days). Moreover, the higher value of intramuscular fat in the females in comparison with the males could be because of the different slaughter age between the sexes. The values of mois-

Table 2. Effect of sex on slaughter performances of Cinisara cattle (least-square means ± SEM).

	Male	Female	P
N	16	12	-
Slaughter age, days	698.7±166.2	827.1±177.3	0.059
Carcass traits			
Weight, kg	379.9±26.64	230.6±39.37	0.001
SEUROP score ^o	4.8±0.83	3.0±1.34	0.004
Fatness score ^f	2.4±0.53	2.5±0.71	0.447
Linear carcass measurements, mm			
Internal carcass length	132.2±10.42	135.1±6.01	0.339
Carcass depth	39.7±2.25	44.1±1.29	0.003
Length of leg	73.3±2.60	77.3±2.05	0.162
Carcass compactness, kg/cm	2.25±0.44	1.70±0.28	0.030
Lateral conformation, %	30.20±2.24	32.68±1.36	0.043

^oSEUROP score: 12 point-scale (S, the best conformation; P, the worst conformation); ^ffatness score: 5-point scale (1, very low fat; 5, very high fat).

Table 3. Effect of sex on physical characteristics of *longissimus thoracis* muscle of Cinisara cattle (least-square means ± SEM).

	Male	Female	P
N	16	12	-
pH, 24 h	5.58±0.09	5.60±0.16	0.402
Lightness, L*	44.90±1.70	43.25±1.33	0.102
Redness, a*	18.03±2.23	17.86±1.04	0.453
Yellowness, b*	15.39±1.69	15.66±1.02	0.409
Hue angle, H*	21.71±2.80	23.76±1.23	0.489
Chroma, C*	0.71±0.02	0.72±0.03	0.247
Cooking loss, %	24.44±7.56	24.98±5.12	0.459
Warner-Bratzler, kg/cm ²	3.36±1.04	3.41±0.31	0.466

Table 4. Effect of sex on chemical characteristics of *longissimus thoracis* muscle of Cinisara cattle (least-square means ± SEM).

	Male	Female	P
N	16	12	-
Moisture, %	74.47±0.68	73.72±1.09	0.170
Crude protein, %	22.58±0.68	21.84±0.49	0.170
Total collagen, %	1.43±0.11	1.57±0.23	0.126
Intramuscular fat, %	1.88±0.17	2.63±0.19	0.114
Salt, %	0.99±0.10	1.62±0.07	0.175

ture are similar to those found by Chladek and Ingr (2003) in Holstein steers fattened up to 10-12 months of age (74.70%), by Spanghero *et al.* (2004) in Italian Simmental young bulls (74.50%) and by Viera *et al.* (2006) in Morucha (75.25%) and crossbreed Charolais x Morucha (74.76%). This suggests a constant content of dry matter of the *longissimus dorsi* muscle across breeds, although different muscles could contain a different amount of dry matter (Lawrie, 1998).

Protein content of the *longissimus* muscle observed in the Cinisara breed (Table 4) is similar to that found by Viera *et al.* (2006) in Morucha (22.40%) and crossbreed Charolais x Morucha (22.72%) cattle, by Destefanis *et al.* (2003) in hypertrophied Piemontese bulls (22.35%) and castrated males (22.49%), by Preziuso and Russo (2004) in Chianina beef cattle (22.16%) and by Fiems *et al.* (2003) in double-musled Belgian Blue bulls (22.10%) and cows (22.20%). Total collagen content in the muscle (Table 4) showed higher values compared with other studies (Chladek *et al.*, 2003; Serra *et al.*, 2008); this could be a result of the collagen determination, which is the least precise analysis, as reported by Dransfield *et al.* (1983). Intramuscular fat content shows the highest variation among the meat quality attributes. This fact is mainly owing to the late deposition rate within the tissue development rate, and because intramuscular fat is an energetic depot that the animal keeps for its own consumption in low feeding conditions. Thus, depending on several intrinsic factors such as age, gender or breed and extrinsic ones such as feeding system or walking conditions, the amount of intramuscular fat will vary (Barker *et al.*, 1995; Yonekura *et al.*, 2002). The intramuscular fat content observed in the Cinisara breed (Table 4) is similar to that found by Preziuso and Russo (2004) in Chianina beef cattle slaughtered at an age between 18 and 21 months (2.32%) and Marino *et al.* (2009) in young Podolian bulls reared in the indoor (1.87%) and outdoor systems (1.85%) in the finishing period, while it was higher than those found by Destefanis *et al.* (2003) in hypertrophied Piemontese bulls (0.71%) and castrated males (1.25%).

Lastly, there has been an important genetic effect on muscle composition reported; for example, dairy cattle have higher marbling than beef cattle (Fisher *et al.*, 1983).

Conclusions

The results obtained in our trial show that

the Cinisara breed of cattle, reared under the traditional production system, could provide meat of good quality. Both physical and chemical characteristics seem to be similar to those of animals of specialised beef breeds. The *longissimus thoracis* muscle showed a good value of redness and tenderness and a good protein and intramuscular fat content. The available literature does not report any slaughter performance and meat quality data for Cinisara cattle and, therefore, the results of our research must be considered as an original set of knowledge useful for the salvage of this endangered, local, native breed. In addition, our results should encourage Sicilian farmers to grow and finish the development of the young male and female stock of the Cinisara native breed of cattle on their farms of origin. This new productive strategy could increase farmers' incomes, especially if this meat is promoted as 'local niche' food obtained from autochthonous cattle, whose husbandry is actively contributing to the maintenance of the fragile Sicilian environment.

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