Livestock Science 145 (2012) 73–78

Contents lists available at SciVerse ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Influence of the housing system on meat quality of double muscled Piemontese young bulls

Alberto Brugiapaglia, Gianluigi Destefanis *

Department of Animal Science, University of Torino, Via L. Da Vinci 44, 10095 Grugliasco, Torino, Italy

ARTICLE INFO

Article history:
Received 29 March 2010
Received in revised form 22 December 2011
Accepted 3 January 2012

Keywords:
Beef cattle
Double muscled Piemontese breed
Housing system
Chemical composition
Physical characteristics
Sensory quality

ABSTRACT

The effect of the housing system on qualitative characteristics of *longissimus thoracis et lumborum* (LTL), *semitendinosus* (St) and *supraspinatus* (Ss) muscles was studied in cattle of hypertrophied Piemontese breed. Thirty young bulls, fifteen tie-stalled and fifteen housed in pens (5 m^2/head of space allowance), were fed the same diet and were slaughtered at about 17 months of age and 560 kg live weight. Chemical analyses (pH_{24}, chemical composition, haem iron and hydroxyproline contents, collagen heat solubility) and physical analyses (colour, water holding capacity, Warner Bratzler shear test) were performed on the three muscles, whilst sensory analysis was carried out on LTL muscle by a trained panel.

Housing in pens increased hydroxyproline content and collagen solubility ($P<0.01$), decreased lightness of the three muscles ($P=0.05$) and influenced the other meat characteristics in a muscle-dependent manner. The loose housing system increased pH_{24} of LTL ($P<0.05$), water content of LTL and St ($P<0.01$), iron content of LTL and Ss ($P<0.05$), redness and yellowness of Ss ($P<0.01$), whilst decreasing protein content and yellowness of LTL and St ($P<0.01$). No significant differences for organoleptic quality due to housing system were observed. On the whole, even if significant, the differences in chemical and physical properties of the meat due to housing system were limited. Therefore, in comparison with the tie-stall housing, the housing in pens might promote the ethical quality of the meat product, being more respectful of animal freedom of movement, without worsening the meat quality.

1. Introduction

The Piemontese breed is highly specialised for beef production due to double muscled phenotype, which depends on a specific mutation in myostatin gene (McPherron and Lee, 1997). This phenotype has been increasingly favoured by artificial selection since the beginning of the 20th century, so that at present the frequency of the responsible allele, *mh*, in the breed is 0.98 (ANABORAPI, 2004).

The *mh* allele affects many traits, including growth rate, meat yield and quality. Double muscling involves both hyperplasia, i.e. an increase in the number of muscle fibres, and, to a lesser extent, hypertrophy, i.e. an enlargement of individual muscle fibres (Ngapo et al., 2002a). This condition is not generalised throughout the body but it is more marked in the hindlimbs than in the forelimbs and mainly affects peripheral muscles and those with a large surface area (Boccard, 1981; Taylor, 2004). Double muscled animals have a higher percentage of white fast contracting muscle fibres. Breeds as Belgian Blue and Piemontese have been shown to have more type IIB fibres and less type I fibres, which partly explains the overall increase in whiteness of meat from hypertrophied animals (Cullen et al., 1999). Thus, the double muscled animals have a higher proportion of fibres adapted for glycolytic metabolism (Boccard, 1981), which results in a faster rate of glycolysis and earlier *post mortem* rigor development, whereas ultimate pH values are generally not different from those of normal animals (De Smet, 2004). Concerning meat quality, the double muscled Piemontese compared with normal animals have higher water and protein content (Barge et al.,

* Corresponding author. Tel. +0039 011 6708569; fax +0039 011 6708563.
E-mail address: gianluigi.destefanis@unito.it (G. Destefanis).

1871-1413/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
doi:10.1016/j.livsci.2012.01.001

1993); the intramuscular fat content is usually about 1% or lower (Barge et al., 1993) and consequently the triacilglycerol content is greatly reduced, as a result of lower fat deposition, with a positive increase of the polyunsaturated/saturated fatty acid ratio (Barge et al., 1993). The meat from double muscled Piemontese animals is also very tender, due to a large reduction in muscle collagen content (Destefanis et al., 1994). Ngapo et al. (2002b) reported that the intramuscular collagen content in meat from double muscled animals was as much as 40% less than in normal animals. This fact is ascribed to the thinner network of perimysial connective tissue (De Smet, 2004). On the contrary, there is little difference in the nature of collagen crosslinks and collagen solubility in meat from double muscled and normal animals (Ngapo et al., 2002a; De Smet, 2004). These findings are in agreement with earlier data of Destefanis et al. (1997), who observed no differences in collagen solubility in hypertrophied and normal animals of Piemontese breed.

Differences have been observed also for colour, which is paler compared with the normal animals (Destefanis et al., 1994), and for drip and cooking loss, which are higher, probably for the faster *post mortem* pH fall (Barge et al., 1996). As reported by Gariépy et al. (1999), the higher percentage of white muscle fibres could explain the paler appearance and reduced water holding capacity.

In the area of production of the Piemontese breed the animals are usually reared in small farms and kept tie-stalled. Even if the loose housing accommodation system is increasingly used, it is estimated that almost half of the farms still adopt the tie-stall system (COALVI, 2006) for reasons linked to traditional rearing habits, and also for the empirical belief of the butchers that the meat of tie-stall animals has better qualitative characteristics, mainly the lighter colour.

However, the tie-stall accommodation is criticised, as the tethered animals have restricted movements and cannot walk or take exercise for long periods or express normal behaviour in relation to social interactions (EU-SCAHAW, 2001). These aspects are not conducive to good welfare and are in contrast especially with two out of five freedom points, i.e. freedom from discomfort and freedom to express normal behaviour (Phillips, 2002).

Moreover, the EU Council Directive 98/58/EC. (1998) established that the freedom of movement of the animal kept for farming purposes must not be limited, and the program of rural development of Regione Piemonte. (2007) provides for change of the housing system from tie-stall to loose housing accommodation, in order to promote rearing system more respectful of freedom of movement of the animals. Besides, the choice of loose housing could give the product an added value, because some consumers' categories are more and more interested in beef production system related to animal welfare.

Previous studies on rearing system and meat quality of young bulls mainly focussed on the effect of indoor and outdoor extensive raising. In general, it has been observed that the physical activity induces a fast to slow-twitch fibre transformation (Jurie et al., 1998; Vestergaard et al., 2000; Gondret et al., 2005), it has no effect on chemical composition, water holding capacity and shear force (Moloney et al., 2004; Dunne et al., 2008), whilst increasing collagen content (Jurie et al., 1998). Concerning colour, the results are inconsistent, but indicate that the effects, if any, are muscle dependent, because they are related to the anatomical location (Muir et al., 1998; Vestergaard et al., 2000; Moloney et al., 2004; Dunne et al., 2005; Dunne et al., 2008). However, few studies exist for hypertrophied breeds, in which the allele responsible for the double-muscled phenotype could interact with the accommodation system for its well-known effect on meat quality.

Therefore, we carried out this study in order to compare tie-stall and loose housing systems for the effects on chemical, physical and organoleptic characteristics of the meat of hypertrophied Piemontese young bulls.

2. Materials and methods

Thirty hypertrophied Piemontese male calves aged 7 months were randomly assigned to two groups of fifteen animals. The animals in one group were tie-stalled (TS), housed on concrete floor with straw bedding; the space allowance of each tie-stall was 1×1.7 m. Those in the other group were loose housed (LH) in three pens with deep bedding (five animals each; 5 m^2/head). The choice of 5 m^2/head space allowance was based on the rules of EU Council regulation 1804/1999 (1999).

The live and slaughtering performances of the animals were reported by Biagini and Lazzaroni (2003). In brief, all the animals were fed the same diet consisting of hay (0.55 UFV/kg) at 2 kg/day and concentrate (0.95 UFV/kg) in varying amount to meet the INRA requirements for 1.2 kg daily gain, as indicated for late maturing beef cattle. The initial average weight of the animals was 225 kg for TS group and 234 kg of LH group. The average length of the trial was 285 days. The slaughtering weight was significantly higher for LH group (573 kg *vs* 539 kg; $P<0.05$), whilst the average daily gain was not significantly different (1.11 kg for TS group and 1.13 kg for LH group). No significant differences were found in carcass weight (TS group: 371 kg; LH group: 397 kg) and in hot dressing percentage (68.91% and 68.51% for TS and LH group, respectively).

Carcass conformation (SEUROP, 1–18 point scale; 2.67 for TS group; 2.33 for T group) and fatness (1–15 point scale; 3.27 for TS group; 2.93 for LH group) were not significantly different (Biagini and Lazzaroni, unpublished data).

The animals were slaughtered in four times, when they reached the same commercial fattening degree. After a transportation time of about 30 min to a commercial abattoir, the animals were slaughtered according to the guidelines of the EU Council Directive 93/119/EC. (1993). The carcasses were split and the sides were stored in a chilling room at 2 °C. Twenty four hours after slaughter, the pH was measured in the *longissimus thoracis* (at the 13th thoracic vertebra level), *semitendinosus* and *supraspinatus* muscles of the right side, by a Hanna pHmeter (Hanna HI9025) with an Ingold spear electrode and automatic temperature compensator.

Seven days after slaughter, the portions of *longissimus thoracis et lumborum* (LTL) muscle between the 9th thoracic and 1st lumbar vertebra, and approximately the central part of *semitendinosus* (St) and *supraspinatus* (Ss) muscles were taken from each right side. These muscles were chosen taking into account that muscle type is one of the most determinant of fibre type (Taylor, 2004). The *longissimus thoracis* and