EFFECT OF AGEING ON PHYSICAL AND SENSORY PROPERTIES OF MEAT FROM PODOLIAN AND LIMOUSINE X PODOLIAN CROSSBRED BULLS

Braghieri A., Giordano D., Cifuni G.F., Napolitano F., Marsico I.
Dipartimento di Scienze delle Produzioni Animali, Università degli Studi della Basilicata, Via N. Sauro 85, 85100 Potenza, Italy

Background

Husbandry of native breeds can provide an opportunity for sustainable use of natural ecosystems and support socio-economic development of Southern Italy marginal areas. Podolian cattle are a local breed, well adapted to the difficulty of surrounding environment (Napolitano and Girolami, 2001). The extensive rearing system used for these indigenous animals minimises the use of chemicals and provides them a natural production environment where they are allowed to display their own proper ethogram. These conditions imply an animal welfare friendly production and the complete safety of products as well as the acquisition of peculiarities closely related to the typical rearing environment. These are the main concerns affecting consumers' preferences (Gregory, 2000; Le Neindre and Terlouw, 2000). Among all meat sensory attributes, tenderness is another important criterion of acceptability for consumers (Campo et al., 2000).

Objectives

In spite of its healthy and tasty peculiarities, Podolian meat is often characterized by a low tenderness (Girolami et al., 1986). Crossbreeding and prolonged ageing time may improve this characteristic (Campo et al., 1999; Macie et al., 2000). This study aims to evaluate the effect of crossbreeding (Podolian vs. Limousine x Podolian) and ageing period (2 vs. 7 days) on physical (pH and WBS) and sensory qualities (flavour and tenderness) of meat.

Methods

Eight Podolian (P) and eight Limousine x Podolian crossbred young bulls (LP), reared according to the traditional local practices (for the first 8 months at pasture and for the following 10 in loose housing conditions with free access to an outside paddock) were used. All the animals were slaughtered at 18 months of age. Mean slaughter weights were 458 ± 7,82 kg and 505 ± 7,82 kg in P and LP subjects. Right and left hind quarters from each carcass were aged at 4°C for 2 and 7 days *post mortem*, respectively. pH was measured at 1, 24 and 48 h *post mortem* on the lumbar region with a portable pH meter (Hanna HI 9025) equipped with a penetrating glass electrode. The sensory analysis (flavour and tenderness) was performed by a trained eight-member panel on *longissimus dorsi* (LD) steaks grilled to an internal temperature of 75°C. Warner- Bratzler shear force was measured on LD cores (1 cm diameter), cut parallel to the direction of the muscle fibres and sheared by an Instron Universal testing machine (model 1140), equipped with a Warner-Bratzler shearing device. Data were analysed with SAS statistical package (SAS, 1990). pH values were analysed using ANOVA for repeated measures with genotype as non-repeated factor and ageing time, post-mortem h and the interactions as repeated factors. WBS data were subjected to ANOVA for repeated measures with genotype as non-repeated factor and ageing time and interaction as repeated factors. Sensory values were normalised standardising each assessor by his standard deviation in order to reduce the effect of the different use of the scale (Naes, 1991). Analysis of variance with genotype (non repeated factor) and ageing and interaction (repeated factors) as the main effects was performed on normalised mean values of tenderness and flavour intensity.

Results and discussion

The rate of LD pH fall (Fig.1) differed in the two groups, with higher pH values in meat from Podolian than crossbred subjects. This is particularly noticeable ($P<0.05$) at 1 and 48 h post mortem. Also Ciria et al. (2000) found differences in ultimate pH values between Charolais and Serrana Soriana breeds. pH24 h in both groups fell within the normal range (5.5 – 5.8) to avoid dark-cutting alteration (Silva et al., 1999), whereas pH 48 h values were lower than those reported by Sinclair et al. (2001) for Aberdeen Angus, Charolais and Holstein steers of 19 months of age. The rate of pH decline is linked to meat tenderness (Purchas and Aungsupakorn, 1993). If pH is too high in the early hours *post-mortem*, then cold-shortening can occur when the temperature of the musculature is lowered too quickly, causing toughening of the meat (Mc Geehin et al., 2001). The relationship between ultimate pH and tenderness is controversial: some authors found a linear relationship between these two parameters (Bouton et al., 1973; Guignot et al., 1994), whereas other authors found a curvilinear relationship with a minimum tenderness between 5.8 and 6.2 pH values (Purchas and Aungsupakorn, 1993; Devine et al., 1993).

As regards sensory attributes (Tab. 1), flavour was not affected by either crossbred or ageing effects. No ageing influence was also reported by Ahmed et al. (1991), comparing different ageing periods (3, 7 and 14 days). Conversely, in our previous findings (Napolitano et al., 2001), Podolian meat flavour intensity increased extending the ageing time from 8 to 15 days. Campo et al. (1999) described a similar pattern, comparing seven European beef breeds whereas they found no breed effect on this sensory parameter. The different results may be due to a shorter ageing period used in the present study. Meat shows significant modifications in the level of numerous chemical components (sugars, organic acids, peptides and free amino acids and metabolites of adenine nucleotide metabolism such as ATP) during postmortem aging. Many of these changes are due to hydrolitic activity (Spanier et al., 1997).

LD showed higher tenderness in crossbred L P than in Podolian bulls (6.31 ± 0.18 vs. 5.11 ± 0.15; $P<0.001$). These results agree with other findings (Gregory et al., 1994; Campo et al., 1999; Macie et al., 2000) showing a significant effect of genotype on tenderness scores. Other studies have also proved that ageing time reduces the toughness difference among breeds (O'Connor et al., 1997; Wulf et al., 1996b). Campo et al. (1999) suggested an early consumption of double muscle breed type after slaughter and a lager ageing period for the rustic breed types to obtain an optimum tenderness value according to consumer expectations. In the present work no significant ageing x genotype interaction was found while ageing period affected significantly tenderness score in both groups ($P<0.001$). Accordantly, Napolitano et al. (2001) observed reduced tenderness in Podolian meat as ageing time decreased. Although the main tenderisation process was sensorially found in the first seven days of ageing (Smith et al., 1978), extending the ageing time up to 21 days would have increased tenderness scores in seven local Spanish beef breeds (Campo et al., 1999; Macie et al., 2000). The most important factor affecting meat tenderisation under normal technological procedures is the enzymatic action, producing myofibrillar and connective degradation throughout ageing (Geesink et al., 1995; Roncalés et al., 1995). This degradation could have been responsible for the decreasing fibrousnesses and residue scores throughout the ageing process, related to more tender meat (Campo et al., 1999).

Ageing had no effect on Warner Bratzler Shear values (Tab. 1), although other authors (Sherbeck et al., 1995; Byrne et al., 2000; French et al., 2001) found a significant decrease in WBS values throughout the ageing period, indicating a significant improvement in meat tenderness.

WBS values were significantly lower in meat from crossbred subjects ($P<0.05$), confirming the higher tenderness scores obtained in this group. Numerous authors attributed genetic differences in beef tenderness to differences in enzymatic activity, fatness or fibre type (O'Connor et al., 1997; Wulf et. al., 1996a; Mandell et al., 1997).

In conclusion, crossbreeding and extending maturation processes improved the organoleptic properties of Podolian meat. The application of these technologies may represents a chance to preserve and promote this native breed, an important resource for the eco-sustainable development of marginal areas of Southern Italy.

Acknowledgments

The research was funded by POP FESR 1999. The authors are grateful to A.M. Riviezzi and F. Surianello for their technical assistance and to Professor L. Zezza for his help.

Pertinent literature

Ahmed, P.O., Miller, M.F., Young, L.L., Reagan, J.O. (1991). *J. Food Sci.*, 56, 1484-1488. Bouton, P.E., Carroll, F.D., Harris, P.V., Shorthose, W.R. (1973). *J. Food Sci.*, 38, 404-407. Byrne C.E., Troy D.J., Buckley, D.J. (2000). *Meat Sci.*, 54, 23- 34. Campo, M.M., Sañudo, C., Panea, B., Alberti, P., Santolaria, P. (1999). *Meat Sci.*, 51, 383- 390. Ciria, J., Asenjo, B., Beriain, M.J., Gorraiz, C. (2000). *Proc. 46th ICoMST, Argentina*, 58- 59. Devine, C. E., Graafhuis, P.D., Muir, P.D., Chrystall, B.B. (1993). *Meat Sci.*, 35, 63-77. French, P., O'Riordan, E.G., Monahan, F.J., Caffrey, P.J., Mooney, M.T., Troy, D.J., Moloney, A.P. (2201). *Meat Sci.*, 57, 379- 386. Geesink, G.H., Koolmees, P.A., Van Lacks, H.L.J.M., Smulders, F.J.M. (1995). *Meat Sci.*, 41, 7-17. Girolami, A., Ferrara, L., Matassino, D. (1986). *I Conv."L'allevamento del bovino Podolico nel Mezzogiorno d'Italia"*, 491-505. Ponticelli (Na), Italy. Gregory, K.E., Cundiff, L.V., Koch, R.M., Dikeman, M.E., Koohmaraie, M. (1994). *J. Anim. Sci.*, 72, 1174- 1183. Gregory, N.G. (2000). Consumer concerns. *Proc. 46th ICoMST, Argentina,* 804-809. Guignot, F., Touraille, C., Ouali, A., Renerre, M, (1994). *Meat Sci.*, 37, 315- 325. Le Neindre, P., Terlouw, C. (2000). *Proc. 46th ICoMST, Argentina,* 122- 123. Macie, S.E., Sañudo, C., Olleta, J.L., Panea, B., Campo,M.M., Alberti,P. (2000). *Proc. 46th ICoMST, Argentina,* 62-63. Mandell, I., Gullett, E.A., Wilton, J.W., Kemp, R. A., Allen, O.B. (1997). *Liv. Prod. Sci.*, 49, 235-248. McGeehin, B., Sheridan, J.J., Butler, F. (2001). *Meat Sci.*, 58, 79-84. Naes, T. (1991). *Food. Qual. Pref.*, 2, 187-199. Napolitano, F., Girolami, A. (2001). *Large Anim. Rev.,* 7 (1), 13- 16. Napolitano, F., Carlucci A., Braghieri, A., Cifuni, G.F., Riviezzi, A.M., Monteleone, E., Girolami, A. (2001). *Zoot. Nutr. Anim.*, 27, 85-89. O'Connor, S.F., Tatum, J.D., Wulf, D.M., Green, R.D., Smith, G., C. (1997). *J. Anim. Sci.*, 75, 1822- 1830. O'Halloran, G.R., Triy, D.J., Buckley, D.J. (1997). *Meat Sci.*, 45, 239- 251. Purchas, R.W., Aungsupakon, R. (1993). *Meat Sci.*, 34, 163- 178. Sherbeck, J.A., Tatum, J.D., Field, T.G., Morgan, J.B., Smith, G.C. (1995). *J. Anim. Sci.*, 73, 3613-3620. Silva, J.A., Patarata, L., Martins, C. (1999). *Meat Sci.*, 52, 453-459. Sinclair., D., Lobley, G.E., Horgan, G.W., Kyle, D.J.,Porter, A.D., Mattehews, K.R.,Warkup, C.,Maltin, C.A. (2001).*Anim. Sci.*,72, 269- 277. Smith, G.C., Culp, G.R., Carpenter, Z.L. (1978). *J. Food Sci.*, 43, 823-826. Spanier, A.M., Flores,M., McMillin, K.W., Bidner, T.D. (1997). *Food Chem.*, 59, 531-538. Wulf, D.M., Morgan, J.B., Tatum, J.D., Smith, G.C. (1996a). *J. Anim. Sci.*, 74, 569-576. Wulf, D.M., Tatum, J.D., Green, R.D., Morgan, J.B., Golden, B.L., Smith, G.C. (1996b). *J. Anim Sci.*, 74, 2394- 2405.

Fig. 1. Rate of pH fall in Longissimus dorsi

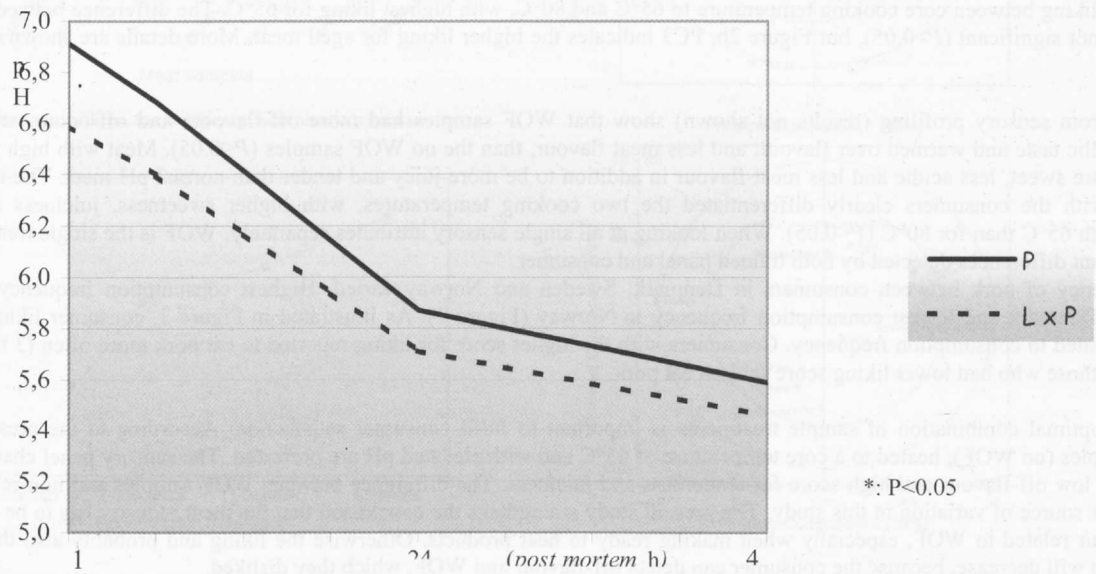

Table 1. Sensory attribute scores and WBS values of Longissimus dorsi (mean± s.e.)

	Ageing		Genotype		Significance		
	2d	7d	P	LP	A	G	A x G
Flavour	5.21 ± 0.15	5.07 ± 0.15	5.18 ± 0.15	5.10 ± 0.15	NS	NS	NS
Tenderness	5.26 ± 0.18	6.15 ± 0.18	5.11 ± 0.18	6.31 ± 0.18	P<0.001	P<0.001	NS
WBS (kg)	2.12 ± 0.16	1.96 ± 0.16	2.27 ± 0.16	1.81 ± 0.16	NS	P<0.05	NS