SHELF LIFE OF MEAT FROM PODOLIAN YOUNG BULLS IN RELATION TO THE AGEING METHOD

Napolitano, F.[1], Braghieri, A. [1], Pacelli, C. [1], Cifuni G.F. [1], Riviezzi, A. M. [1], Grasso, F. [2], Girolami, A. [1]

[1]Dip. Scienze delle Produzioni Animali, Università degli Studi della Basilicata, Via dell'Ateneo Lucano 10, 85100 Potenza, Italy [2]Dip. Scienze Zootecniche e Ispezione degli Alimenti, Via Università 133, 80055, Portici (NA), Italy

Background

During production, processing, distribution and storage, meat undergoes deterioration from chemical and microbial processes. Meat shelf life is an important parameter since consumers discriminate against meat cuts that have lost their fresh appearance and meat that becomes discoloured is often ground and marketed in reduced-value form. Lipid oxidation is one of the primary mechanism of quality deterioration in meat during display and it is directly related to the formation of precursors of oxymyoglobin oxidation and metmyoglobin (Insausti et al., 2001).
Ageing is an important factor influencing the final perception of meat quality and tenderness is the main parameter affected by this technological factor (Campo et al., 1999). This is particularly relevant for the improvement of meat properties of local breed such as Podolian, which is known to be tasty albeit though (Girolami et al., 1986). Previous works showed significant tenderness enhancement of Podolian meat extending maturation processes (Braghieri et al., 2002; Cifuni et al., 2004).

Objectives

Holding carcasses for prolonged time during ageing may produce chilling and technological losses. Ageing individually the various commercial cuts in vacuum packaging may represent a chance to improve tenderness avoiding this problem. On the other hand Lanari et al. (1989) found that beef aged in vacuum packaging may be darker in colour when removed from package due to the lack of oxygen. Shelf life could be also affected by the ageing method. This study aims to assess the effect of the ageing method (on the carcass or under vacuum packaging) on physical and sensory properties of Podolian meat. Meat shelf life under retail display in relation to the aging method was also evaluated.

Materials and methods

Eight Podolian young bulls, 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 16÷18 months of age. Mean slaughter weight and dressing percentage were 237 kg and 53%, respectively. *Longissimus dorsi* (LD) and *Semitendinosus* (ST) muscles were removed from the right carcass side 48 h *postmortem*, vacuum-packaged and aged for 5 days at 4°C. The same muscles were taken from the left carcass side previously stored for 7 days at 4°C. Muscles were sliced (2.5 cm thickness), then placed on a polystyrene tray, wrapped in a polyvinylchloride film and displayed for five days at 2°C under 8 h illumination from cool white fluorescent lights (350 lux).
Lipid oxidation was determined by measuring 2-thiobarbituric acid reactive substances (TBARS), according to the method of Salih et al. (1987), at days 0, 2 and 4 and was expressed as mg malondialdehyde (MDA) produced per kg muscle.
Water loss was estimated by weighing the empty pack (Wp) and the pack with meat (Wp+m) on day 0. After storage the meat was removed from the pack and the weight of the pack plus the juice (Wp+j) was recorded. Water loss was expressed as a percentage of the initial weight of the meat (Insausti et al., 2001):

$$\% \text{ water loss: } \frac{(Wp+j) - (Wp)}{(Wp+m) - (Wp)} \times 100$$

CIE L*, a*, b* were measured at day 0, 1, 2, 3, 4 using a Minolta Chromameter (Minolta Co., Ltd, Osaka, Japan).
Microbial count was performed at day 0, 2 and 4 for total viable count (TVC) on Plate Count Agar (Difco) at 30°C for 72 h and *Lactobacillus* spp. on MRS Agar (Difco) at 37°C in anaerobic environment for 72 h.

Warner-Bratzler shear force was measured on LD and ST cores (1.27 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.
The sensory analysis (flavour and tenderness) was performed by a trained eight-member panel on LD and ST steaks grilled to an internal temperature of 75°C. Sensory values were normalised standardising each assessor by his standard deviation in order to reduce the effect of the different use of the scale (Cifuni et al., 2004). Data were subjected to analysis of variance for repeated measures with muscle, ageing technique and the interaction muscle x ageing method as repeated factors.

Results and discussion

The ageing method did not markedly affect colour parameters (Fig.1). Conversely other studies (e.g. Boakye and Mittal, 1996) observed that L index significantly increased in LD vacuum aged. In agreement with previous studies (Monin and Ouali, 1992; Torrescano et al., 2003), colour was significantly affected by muscle with higher L (36,32 ± 0,25 vs 36,32 ± 0,25; $P<0.001$) and lower a* (20,44 ± 0,18 vs 21,04 ± 0,18; $P<0.05$) values in ST compared with LD muscle. Muscle function is the most obvious factor accounting for colour differentiation between muscles according to the metabolic types. Intensity of meat colour depends on both the pigment level and surface structure (Monin and Ouali, 1992). Display time affected muscle colour (Fig.1). As also observed by Eikelenboom et al. (2000), for both muscles, redness a* value incresed after 1 day of display and subsequently decresed. The decrease in redness a* values may result from the gradual formation of metmyoglobin on the meat surface, because they have been reported to be negatively correlated (Insausti et al., 1999). It was noterworty that during the same time, there was an increase in TBARS value (Fig. 2). Previously, it was noted that a* redness was negatively correlated with lipid oxidation measured by TBARS values (Anton et al., 1993). According to Chan et al. (1997) the process of myglobin oxidation is a catlyst of lipid oxidation. Colour of fresh meat is a major factor affecting meat acceptability. In red meats, consumers relate the bright red colour to freshness, while discriminating against meat which has turned in brown (Zerby et al., 1999). Lipid oxidation, as indicated by MDA concentration, was not affected by the ageing method. One of the main factors limiting the quality and acceptability of meat products is lipid oxidation. This process leads to discolouration, drip losses, off-odour and off-flavour development and the production of potentially toxic compounds (Gray et al., 1996).
Lipid stability significantly varied between muscles, with higher MDA content in ST than in LD (0,072 ± 0,004 mg/kg meat vs. 0,048 ± 0,004 0,048 ± 0,004, respectively; $P<0.001$). The lower lipid stability observed in *Semitendinosus* muscle may be due to its higher polyunsaturated fatty acid content compared to *Longissimus dorsi* (Cifuni et al., 2004). However, for both muscles and during display the MDA content was well below the threshold value for rancidity of 1- 2 mg/kg of meat (Watts, 1962).
Microbial spoilage of food occurs when total aerobic counts reach 10^7 CFU/g (Nortje and Shaw, 1989). In the present work, TVC increased during display (Fig. 3), as previously reported by Zerby et al. (1999), but not to that level. Bacteria can produce colour changes in beef stored in air due to a reduction in the oxygen concentration at the surface tissue due to microbial respiration (Nortje and Shaw, 1989). TVC ($P<0.001$) and lactic bacteria ($P<0.01$) significantly differed in relation to ageing method with higher values in vacuum ageing method.
Water loss, an indicator of water holding capacity of muscle, may influence consumers choice, when purchasing packaged meat, as too much exudates around the meat is not appealing (Insausti et al., 2001). Drip loss may result from shrinkage of myofibrils *post mortem*, due to pH-fall, denaturation of myosin and formation of actomyosin at the onset of *rigor mortis* (Den Hertog-Meischke et al., 1997). In the present study neither ageing method nor muscle affected water loss (tab. 1).
Although Kannan et al. (2002) reported no effect of ageing method on WBS values of goat meat, in the present study meat aged under vacuum showed higher tenderness, as indicated by lower WBS value ($P<0.01$), compared with meat aged conventionally (tab. 1). No significant differences may be detected for sensory tenderness score between the two maturation method (tab. 1). As previously observed (Torrescano et al. 2003), shear force was significantly affected by muscle, with lower shear values muscle (2.00 ± 0.11 kg vs 2.63 ± 0.11 kg; $P<0.01$) and higher sensory tenderness score (5.90 ± 0.10 vs 5.62 ± 0.10; $P<0.05$) for LD compared with ST muscle. The ageing method and muscle had no effects on flavour of meat (tab. 1).

Conclusions

The ageing method did not markedly affect meat quality and shelf life. This result may encourage to employ vacuum packaging in the ageing of primal cuts from Podolian carcasses avoiding chilling and technological losses that generally occur in traditional maturation method.

Acknowledgments

The research was funded by POP FESR 1999. The authors are grateful to Dr. M. Palazzo, Istituto Zooprofilattico Sperimentale della Puglia e della Basilicata, Potenza for her technical assistance.

References

Anton, M., Gatellier, P. and Renerre, M. 1993. *Proc. 39th ICoMST,* Calgary, Canada.

Boakye, K. and Mittal, G.S. 1996.

Braghieri, A., Giordano D., Cifuni G.F., Napolitano F., Marsico I. 2002. Effect of ageing on physical and sensory properties of meat from Podolian and Limousine x Podolian crossbred bulls. Proc. of the 48th ICoMST. Rome, 25-30 August.

Campo, M.M., Snudo, C., Panea, B., Alberti, P. and Santolaria, P. 1999. Meat Sci., 51: 383-390.

Chan, W.K. M., Faustman, C. and Decker, E.A. J. Food Sci., 62: 709- 712.

Cifuni, G.F., Napolitano, F., Riviezzi, A.M., Braghieri, A. and Girolami, A. 2004. Meat Sci. 67: 289-297.

Den Hertog-Meischke, M. J. A., Smulders, F. J. M., Houben, J. H. and Eikelenboom, G. 1997. Meat Sci. 45: 153-160.

Eikelenboom, G., Hoving-Bolink, A. H., Kluitman, I.,Houben, J. H. and Klont, R. E. 2000. Meat Sci., 54: 17-22.

Girolami, A., Ferrara, L. and Matassino, D. 1986. I Conv. "L'allevamento del bovino Podolico nel Mezzogiorno d'Italia". Acerno (SA), 491-505.

Gray, J. I., Gomaa, E. A. and Buckley, D. J. 1996. Meat Sci., 43, suppl.1 , S111-S123.

Insausti, K., Beriain, M. J., Purroy, A., Alberti, P., Lizaso, L. and Hernandez, B. 1999. Meat Sci.,, 53: 241-249.

Insausti, K., Beriain, M. J., Purroy, A., Alberti, P., Gorraiz, C. and Alzueta, M. J. 2001. Meat Sci., 57: 273-281.

Kannan, G., Chawan, C. B., Kouakou, B. and Gelaye, S. (2002). J. Anim. Sci. 80: 2383-2389.

Monin, G. and Ouali, A. (1992). In *Developments in Meat Science,* 5. ed. R. Lawrie, pp. 89-157. Elsevier Applied Science, London.

Nortje, G.L. and Shaw, B.G. 1989. Meat Sci., 25: 43-58.

Salih, A. M., Smith, D. M., Price, J. F. and Dawson, L. E. (1987). Poultry Sci. 66: 1483.

Torrescano, G., Sànchez-Escalante, A., Gimènez, B., Roncalès and P., Beltràn, J. A. 2003. Meat Sci.., 64: 85-91.

Watts, B. M. 1962. Meat products. In *Symposium on Food: Lipid and Their oxidation*, ed A Day. And R. P. R. Simhulber. 202-219. AVI Publ. Co., Westport, CT, USA.

Zerby, H.N., Belk, K.E., Ahola J.K., Sofos, J.N., Schaefer, D.M., Morgan, J.B. and Smith, G.C. 1999. Meat Sci., 52: 111-118.

Table 1. Meat characteristics: effect of ageing method (mean ± SE)

	V	C	P
Flavour	6.33 ± 0.09	6.10 ± 0.09	**
Tenderness	5.77 ± 0.10	5.75 ± 0.10	NS
WBS (kg)	2.03 ± 0.11	2.61 ± 0.10	**
Water loss (%)	0.47 ± 0.05	0.50 ± 0.05	NS

Fig. 1. Redness (a*) of beef during meat display at 2°C

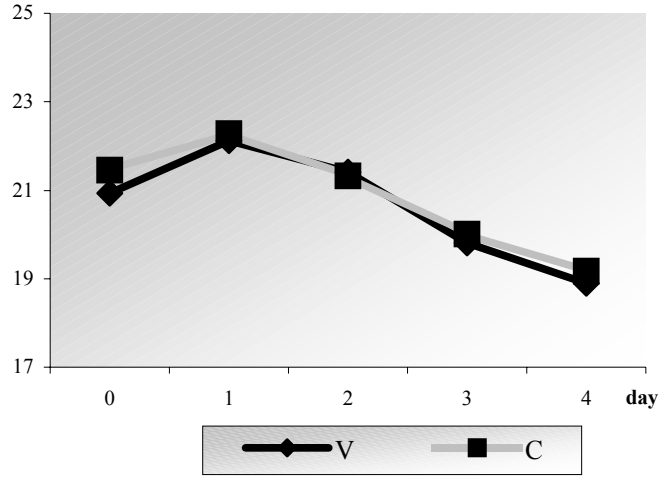

Fig. 2. Levels of 2-TBA values (mg MDA/kg product) during meat display at 2°C

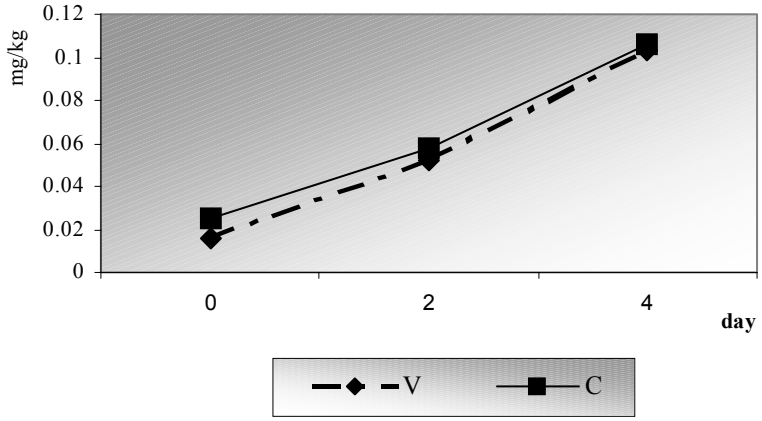

Fig.3. Microbial counts of beef: effect of ageing method