Comparison among some tenderization processing on Maremmana meat

Michela Contò, Silvia Ballico, Antonella Ficco, Maurizio Mormile, Sebastiana Failla

C.R.A. - P.C.M. Consiglio per la Ricerca e Sperimentazione in Agricoltura, Centro Produzione della Carne e il Miglioramento genetico, Monterotondo, Italy

Corresponding author: Michela Contò. C.R.A. - Centro Produzione della Carne e il Miglioramento genetico. Via Salaria, 31, 00016 Monterotondo (Roma), Italy - Tel. +39 06 90090216 - Fax: +39 06 9061541 - Email: michela.conto@entecra.it

ABSTRACT - Tenderness is the most important characteristic to define acceptability of products by consumers. In this paper three different methods, Calcium infusion (Ca), Very Fast Chilling (VFC) and pelvic suspension hanging from aitch bone (PS) or the Achilles tendon (AT) are applied in pre-rigor phase on Maremmana meat. Ca injection has reported the lowest shear force on cooked meat compared to control group (5.09 vs. 16.33 kg) instead VFC group has underlined intermediate values. Pelvic hanging has shown significant difference on shear force and sarcomere length on Longissimus thoracis muscle (4.13 vs. 8.11 kg and 1.63 and 2.04 µm respectively for WBS and sarcomere length in PS and AT); further in Biceps femoralis we have found a lowest collagen content (4.33 vs. 4.79 g/100 g for PS and AT). In conclusion these methods could influence tenderization processes even if some processes, that could lower the effect of these practices, are still unclear.

Key words: Meat tenderization, Ca infusion, Very Fast Chilling, Ageing time.

Introduction - Tenderness is the most important characteristic of meat quality as reported in many researches. This characteristic is modified by several factors like age, livestock management and breed (Dransfield, 1994). Therefore, in many researches extensive breeding was observed to produce a tougher meat than intensively one, hence that meat is generally less accepted by consumers. Some Italian breeds like Maremmana have high meat nutritional quality but its meat is penalized because it is usually rather tough (Gigli et al., 2000). In order to improve this aspect, and exploiting the knowledge on proteolytic activity during ageing, different techniques have been tested on carcasses during pre-rigor mortis phase in the last ten years. These techniques have a mechanical, and/or biochemical action. A particular mechanical practice is suspension of beef carcasses by the pelvic girdle (tenderstretch) to produce during rigor a decrease of myofibrils shortening and a connective tissue structural change (Ahnström et al., 2006). Another one, with biochemical action, is post mortem CaCl₂ injection, that leads to an advanced and increased activity of Ca dependent enzymes (Gerelt et al., 2002), and, at last, very fast chilling (VFC). A fast cooling allows a strong muscle contraction, with release of calcium into myofibrils, and an outcoming activation of proteolytic enzymes (Van Moeseke et al., 2001), which produces a mechanical and biochemical action on myofibrillar structure. The aim of this paper is to compare different tenderization methods during ageing to decrease hardness in Maremmana breed meat.

Material and methods - Six Maremmana young bulls were slaughtered at about 590 days old with a carcass weight of 313 ± 11.40 kg. After slaughtering, the left side was suspended from the aitch bone (Pelvic Suspension, PS) for 24 hours, while the right side from the Achilles Tendon (AT). After 30 minutes from right side the Longissimus thoracis (Lt) was taken (between 8th and 13th rib) and subdivided into three portions to carry out three different thesis: “C” (Control) traditional ageing; “Ca” (CaCl₂ infusion) injecting inside muscle 9% of meat weight (wt/wt) of 300 mM CaCl₂; “VFC” (Very Fast Chilling) obtained
putting samples into a freezer at -70°C and storing them until the core have reached 1°C of temperature. Both carcasses (PS and AT) were aged for 8 days and stored at 2°C ± 1°C. At dissection, Longissimus thoracis (Lt) at the 7th rib and Biceps femoralis (Bf) were taken off, and physical analysis at only 8 days were determined; whilst the three thesis were studied at three different times: 24 hours, 5 and 8 days. On each sample, the following analyses for physical and chemical characteristics were performed: temperature and pH values, with penetration through meat (monitored since 8 hours after slaughtering with 1 hour step); drip loss (Chrystall et al., 1994) with gravimetric method on raw meat preserved at 4°C for 8 day (Barton-Gade et al., 1993), and cooking loss obtained cooking samples vacuum-packed in polyethylene bag in water bath at 75°C for 50'; shear force on cooked meat (WBS) on 6 samples (1x1 cm cross section and 2 cm long), using Warner Bratzler Share apparatus on Instron 5543; sarcomere length by measuring ten fibres on raw meat by immersion optical microscope; total and insoluble collagen by hydroxyproline quantification (Kolar, 1990). The statistic analysis of variance was performed on GLM procedure of SAS software (SAS, 1985) using a bifactorial model (treatment and muscle for tenderstretch test, treatment and time for the other tests).

Results and conclusions - Ca group showed a more rapid pH fall than the other groups (Figure 1) during the first 2h post mortem, even if at 8h this group reached a similar value in comparison with others. In fact at 24h the ultimate pH did not show significant difference between groups and this is also reported by Jaturasitha et al., (2004). Rapid chilling (VFC) system decreased the samples temperature from 35°C to 7.5°C during the first hour of treatment, whilst the other groups reached this temperature in 8 h. Similar trend is found by King et al. (2003).

Figure 1. pH trend in the three different thesis.

Shear force on cooked (Table 1) showed an evident calcium infusion effect during ageing time, reporting the lowest values at every time (5.09 kg on average for three times vs. 16.33 kg and 9.37 kg respectively for C and VFC groups), because more amount of Ca produced a greater activation of calcium depending enzymes during the first day of ageing (Gerelt et al., 2002). No differences between groups were found in cooked loss; whilst drip loss at 24h was highest in Ca samples, because meat lost the liquid introduced by CaCl₂ injection, at last, VFC group has always a median value, compared to other groups. Total collagen did not show significant differences between the three theses during the ageing, whilst insoluble collagen was significantly different during ageing time between VFC group and control, and Ca thesis showed intermediate values. Highest value in insoluble collagen probably depends on cold contraction occurred during the first hours producing more links in the collagen tail. Sarcomere length in fact showed higher value just at 24h in C group than the others (1.62 vs. 1.43 µm), but no differences were at 8 d from slaughtering.

Pelvic suspension (Table 2) reported significant differences for WBS in cooked meat and sarcomere length in Lt muscle that showed the lowest value for WBS (4.13 vs. 8.11 kg) and highest value on sarcomere length (2.04 and 1.63 µm) as reported in Ahnström et al. (2006). In Bf muscle significant values were found in total and insoluble collagen where PS thesis showed lowest values. This trend could be explained by mechanical action of stretching that probably breaks the collagen links. In conclusion all these methods, with different actions, have positive effects on tenderization during a short ageing, but there are still a lot of unclear processes that might lower the efficiency of these procedures during longer ageing period.
REFERENCES - Ahnström, M.L., Enfält, A.C., Hansson, I., Lundströ, K., 2006. Pelvic suspension improves quality characteristics in M. semimembranosus from Swedish dual purpose young bulls. Meat Sci. 72:555-559. Barston-Gade, P.A., Demayer, D., Honikel, K.O., Joseph, R.L., Poulanne, E., Severini, M., Smulders, F.S.M., Tornberg, E., 1994. Final version of reference methods for water holding capacity in meat and meat products: procedures recommended by an OECD working group. ICoMST 40st Nederlands S-V. 05. Chrystall, B.B., Culioli, J., Demeyer, D., Honikel, K.O., Moller, A.J., Purslow, P., Schwagele, F., Shorthose, R. and Uytterhagen, L., 1994. Recommendation of reference methods for assessment of meat. Dransfield, E., 1994. Optimisation of tenderisation, ageing and tenderness. Meat Sci. 36:105-121. Gerelt, B., Ikeuchi, Y., Nishiumi, T., Suzuki, A., 2002. Meat tenderization by calcium chloride after osmotic dehydration. Meat Sci. 60:237-244. Gigli, S., Iacurto, M., Giorgetti, A., Bozzi, R., Poli, B., Franci, O., Failla, S., Lucifero, M., 2000. Caratteristiche della qualità della carne di una razza specializzata da carne (Chianina) ed una rustica (Maremmana) allevate in Italia. TAURUS 11:75-92. Jaturasitha, S., Thirawong, P., Leangwunta, V., Kreuzer, M., 2004. Reducing toughness of beef from Bos indicus draught steers by injection of calcium chloride: effect of concentration and time postmortem. Meat Sci. 61:33-69. King, D.A., Deikman, M.E., Wheeler, T.L., Kastenr, C.L., Koohmaraie, M., 2003. Chilling and cooking rate effects on some myofibrillar determinants of tenderness of beef. J. Anim. Sci. 81:1473-1481. Kolar, K., 1990. Colorimetric determination of hydroxyproline as measure of collagen content in meat and meat products: NMKL collaborative study. J. Ass. Off. Ana. Chem. 73:54-77. SAS, 1985. SAS user’s guide statistics. Ed. Cary (NC) SAS Institute Inc. USA. Van Moeske, W., De Smet, S., Claes, E., Demeyer, D., 2001. Very fast chilling of beef: effects on meat quality. Meat Sci. 59: 31-37.

Table 1. Physical and chemical analyses during ageing on Lt treated with three different methods.

|                | 24 hours | 5 days | 8 days | Means | RMSE |
|----------------|----------|--------|--------|-------|------|
|                | C    | CaCl₂ | VFC   | C    | CaCl₂ | VFC   | C    | CaCl₂ | VFC   |
| WBS cooked kg  | 13.47ₐ | 6.85ₗ | 10.63ₗ | 11.56ₗ | 4.90ₗ | 9.14ₗ | 10.49ₗ | 3.51ₗ | 8.33ₗ | 8.76 | 1.655 |
| WHC cooked %   | 22.71 | 23.51 | 22.49 | 25.20 | 22.93 | 25.29 | 28.01 | 26.69 | 27.97 | 24.98 | 2.433 |
| WHC raw %      | 0.91ₘ | 1.9ₙₘ | 1.4ₘₗₙ | 1.8ₙₘ | 2.2ₙ | 2.3ₙ | 2.5₂ | 3.1ₙ | 2.9ₘ | 2.1ₙ | 0.6ₘₙ |
| Total collagen g/100 g | 3.3ₘ | 3.8ₙ | 4.0₁ | 3.3ₙ | 3.8ₙ | 4.0₁ | 3.3ₙ | 3.8ₙ | 4.0₁ | 3.7ₙ | 0.6₂ₙ |
| Insoluble collagen g/100 g | 2.6ₘₙ | 3.1ₘₙ | 3.ₙₘ₉ | 2.ₙ₉ | 3.ₘ₉ | 3.ₙ₉ | 3.ₙ₉ | 3.ₙ₉ | 3.ₙ₉ | 3.ₙ₉ | 0.ₙ₉₉ |
| Sarcomere µm   | 1.ₘₙ | 1.ₙₘ | 1.ₙₘ | 1.ₙₙ | 1.ₙₙ | 1.ₙₙ | 1.ₙₙ | 1.ₙₙ | 1.ₙₙ | 1.ₙₙ | 1.ₙₙ |

A,B,C =P< 0.05

Table 2. Physical and chemical analyses on Lt and Bf muscles on PS and AT.

|                | Pelvic suspension (PS) | Achilles tendon suspension (AT) | Means | RMSE |
|----------------|------------------------|-------------------------------|-------|------|
|                | Lt  | Bf  | Lt  | Bf  |       |      |
| WBS cooked kg  | 4.1ₘ | 5.2ₙ | 8.₁ₘ | 6.ₙ₉ | 6.₀ₙ | 2.ₙ₉ |
| WHC cooked %   | 3.₀ₘ | 2.ₙ₉ | 2ₘₙ | 2ₙ₉ | 2ₙ₉ | 1.ₙ₉ | 1.ₙ₉ | 1.ₙ₉ | 1.ₙ₉ | 1.ₙ₉ | 1.ₙ₉ |
| Total collagen g/100 g | 2.ₙₙ | 4.ₙₙ | 2.ₙₙ | 4.ₙₙ | 2ₙₙ | 4.ₙₙ | 2ₙₙ | 4.ₙₙ | 2ₙₙ | 4.ₙₙ | 2ₙₙ |
| Insoluble collagen g/100 g | 1.ₙₙ | 2.ₙₙ | 1.ₙₙ | 2.ₙₙ | 1ₙₙ | 2ₙₙ | 1ₙₙ | 2ₙₙ | 1ₙₙ | 2ₙₙ | 1ₙₙ |
| Sarcomere µm   | 2.₀ₙ | 2.ₙₙ | 1.ₙ₉ | 1.ₙ₉ | 1.ₙ₉ | 1.ₙ₉ | 1.ₙ₉ | 1.ₙ₉ | 1.ₙ₉ | 1.ₙ₉ | 1.ₙ₉ |

A,B =P< 0.05