CARCASS TRAITS AND SELECTED QUALITY CHARACTERISTICS OF RAW AND COOKED MEAT OF RAM LAMBS

BADIANI A., GATTA P.P., NANNI N. and MANFREDINI M.

Istituto di Approvvigionamenti Annonari, Università degli Studi di Bologna, Italy

S-IVA.48

SUMMARY

Unweaned ram lambs of Suffolk breed were characterized for carcass and meat quality traits and utilized to evaluate the effects induced by roasting on some physico-chemical features of rib-loin and leg, with special reference to *longissimus thoracis et lumborum*, *biceps femoris* and *semimembranosus* muscles. Statistically significant differences emerged between cuts as regards extent and evolution of cooking loss, as well as moisture and protein contents of cooked lean. Despite similar degrees of doneness, the three muscles showed noticeable differences as for extractable collagen and WB shear values, which could be explained on the basis of different reactions to heat treatment.

Introduction

The research here reported is part of a wider study aimed at assessing cooking-induced changes in physico-chemical and nutritional properties of lamb meat. As a first approach to the problem, the investigation has evaluated the effect of cooking on meat of rib-loin and leg from ram lambs. The parameters studied included weight loss, proximate composition of the lean, total and soluble collagen content, instrumental colour and toughness. Carcass traits were also recorded, together with some fresh meat quality features.

Materials and methods

Unweaned Suffolk ram lambs (n=10) were slaughtered during the spring months at an average liveweight of 35.9 kg using standard commercial practices. Dressing percentage was calculated as hot carcass weight/liveweight at slaughter. The scores for carcass conformation and fatness (EEC, 1992) were converted in "1 to 15" point scales (Dransfield et al.,1990), from 1 = poor conformation or minimum fatness, to 15 = excellent conformation or maximum fatness. The following meat quality traits were determined: 1) pH and temperature on M. *longissimus thoracis et lumborum* (LTL), at 1 and 24 hours *post mortem* (hr p.m.); 2) water holding capacity (WHC) on LTL according to Grau and Hamm (1957), to determine total wet surface (cm^2) and weight loss of the meat sample due to compression (expressible juice, %), at 1 and 24 hr p.m.; 3) sensory and instrumental colour on a freshly cut surface of Mm. *pectorales profundi* (PP) at 1 hr p.m., the former with the aid of standard models (Nakai et al., 1975), the latter with a Minolta Chromameter Reflectance II CR 200/08 (CIE L* a* b* system, with computation of Chroma = $(a^{*2} + b^{*2})^{0.5}$ and Hue = arctan b*/a*).

The carcasses were conditioned in order to avoid cold shortening (room temperature up to 4 hr p.m., 10-11 _C up to 24 hr p.m.) and then held at 4 _C up to 48 hr p.m. Dissection (at 48 hr p.m.) yielded 5 primal cuts/side. Both legs and rib-loins (6th thoracic vertebra - 6th lumbar vertebra) were kept for further processing during the following 24 hr. A pair of cuts from the left and right side in turn (mean weight: rib-loin 1.215 kg; leg 2.816 kg) were roasted in a preheated electric convection oven (165 _C for leg, 150 _C for rib-loin cooking, in order to reach the same degree of doneness) to an internal temperature (temp.) of 75 _C, following AMSA (1978) guidelines. Cooking time was recorded for each roast. Evaporative and drip losses were determined at four different stages: upon removal from oven (T0); at the end of post-cooking temp. rise (T1); when the internal temp. dropped to 50 _C (T2) and when it finally equalled room temp. (T3). Both the cooked cuts and the controlateral raw pairs were dissected after chilling. Mm. *semimembranosus* (SM), *biceps femoris* (BF) and LTL were isolated for: 1) sensory (only raw LTL) and instrumental assessment of colour on freshly exposed surfaces cut across the fibres; 2) Warner-Bratzler (WB) shear force values (4 to 6 cores/muscle, 1.27 cm in diameter, with 2-3 shears/core perpendicular to the muscle fibres).

The sheared cores and adjoining muscle tissue were freeze dried and defatted. Total and soluble (extractable) collagen (expressed as mg/g fresh-tissue basis and % total collagen, resp.) were determined in triplicate on each muscle according to procedures described by Woessner (1961) and Hill (1966), modified for cooked samples as suggested by Paul et al. (1973). Soluble and residual hydroxyproline contents were converted to collagen using convertion factors 7.52 and 7.25, resp. (Cross et al., 1973). The remaining parts of LTL, SM and BF were added to and homogenized together with the lean tissue dissected from the respective original cut for chemical composition (moisture, protein and ash according to AOAC, 1990; total lipids with the method of Folch et al., 1957).

All data were analysed using a two-way "between group-repeated measures" analysis of variance, with "cut" (C) or "muscle" (M) as the between-group factor. The within-subjects factor was usually "state" (S), except for cooking losses, where "time of measurement" (T) was used. Means were separated at, or below, the 5% level of significance using the Scheffé test. Pearson correlation coefficients were calculated for selected pair-wise combinations of dependent variables (StatSoft Inc., 1992).

Results and discussion

Carcass traits collected at slaughter (Table 1) were satisfactory. Among fresh meat quality features (Table 2), *post mortem* pH fall was worthy of notice for its rate and extent, while colour measures exibited lower L* and Chroma values in PP 1 hr p.m., as opposed to LTL 48 hr p.m.. Correlations between the two muscles, though, were not significant. Instrumental colour values fell inside the range observed by Sañudo et al. (1993) in light lambs on one side and by Thatcher and Gaunt (1992) in heavier animals on the other side. Colour sensory evaluation came out with slightly lower scores for LTL and, only for LTL, showed a positive relationship with a* ($P<0.05$) and a negative one with Hue ($P<0.01$). Bolink et al. (1990), using the same standards, found values lying between 3.3 and 3.8. with similar type lambs. On the whole, therefore, it appears that meat colour of lambs employed in the research was quite intense, both as regards instrumental measures and sensory scores.

Mean cooking times were 47.45 min/kg for the leg, 57.09 min/kg for the rib-loin. Both evaporative and drip losses, and thus overall loss, were higher in the leg than in the rib-loin (Table 3). In neither of the cuts did the evaporative loss differ significantly between T0 and T1, or between T2 and T3. No significant differences were found in drip loss between T2 and T3 for either cut, nor in total loss for the leg. The differences between T1 and T2 were significant in all cases, with the exception of drip loss for the leg. This is understandable enough, given the long time needed for the core temp. in both cuts to drop to 50 _C from the value reached at the end of post-cooking rise. On the basis of the results of this study, it would seem advisable to check on weight changes at least until the core temperature drops to 50 _C (T2). This is in contrast to the guidelines laid down by AMSA (1978), which suggest to stop weighing at the maximum post-cooking temp. (T1). The overall loss for the leg upon removal from the oven was close to that reported by Jeremiah (1988) and by Jeremiah et al. (1993). In comparison to the latter study, however, the evaporative loss was higher and the drip loss lower. Generally, data in literature show the weight loss of the rib-loin to be lower than that of the leg, ranging between 15 and 25% (Solomon et al., 1980; Griffin et al., 1985; Dransfield et al., 1990).

The two cuts did not differ significantly as regards raw lean composition, but significant differences in moisture and protein contents were observed after cooking (Table 4). By and large, lipid content of raw and cooked lean of both cuts was lower than literature values.

The instrumental colour of LTL was not significantly different from that of BF or SM, either before or after cooking (Table 5). According to Zondagh et al. (1986), instrumental colour is related to degree of doneness in lamb meat, with cooking conditions having a significant effect on both. Thus, judging from the chromatic coordinates of cooked LTL, BF and SM, the degree of doneness of the cuts examined in this trial should have been similar.

The highest total collagen content was found in BF, followed by SM and LTL (Table 6). As for soluble collagen, raw muscle values were rather high, especially in BF. Correlation coefficients between soluble collagen in raw muscles were highly significant, i.e. 0.892*** (BF-SM), 0.832** (BF-LTL) and 0.816** (LTL-SM). The amount of collagen extractable after cooking was much lower in LTL and SM, than in BF. Only in the case of LTL, though, the decrease in extractable collagen induced by cooking was related to drip loss ($r = 0.746^*$ at T2, $r = 0.785^*$ at T3).

Raw LTL, BF and SM did not differ significantly as regards WB shear values (Table 6). Such values did not increase after cooking in BF, as it happened, instead, in SM and, to a statistically significant extent, in LTL. In the last muscle, though, a greater variability was observed.

The overall (n = 30) correlation coefficient between WB shear value and soluble collagen was rather low, but significant, for the cooked state (r = -0.475**), whereas the only significant correlation when considering the same variables in each single muscle emerged for cooked SM (r = -0.706*).

Such results should be interpreted by keeping in mind the anatomical location of the muscle, its intactness and the type of heat treatment. Cooking of both cuts was halted when the geometric centre had reached 75 _C. Rib-loin centre coincided with LTL core, whereas in the leg the centre was much deeper than SM and, even more, than BF. It is therefore likely that BF was cooked both more severely and faster than SM, and especially, than LTL. The latter two muscles, moreover, had exposed cut surfaces, while BF was intact and completely covered with the epimysium sheath. When cooking was stopped, it was observed that a considerable leakage of solubilized collagen had taken place in LTL and SM. The appearance of the two muscles at the end of cooking and the increase of their WB shear values would suggest that LTL, and to a lesser extent SM, were at the time subjected to perimysium shrinkage. Packing of muscle fibres and exudation of moisture from myofibrils ensued (Hamm, 1977; Light et al., 1985). The much smaller change in BF extractable collagen than in LTL and SM, observed after cooking, could be explained by the fact that the first muscle was intact and, therefore, much less prone to leakage. What's more, as BF was exposed to more severe cooking conditions, it may not be ruled out that greater disruption of connective tissue and myofibrillar fragmentation occurred in this muscle (Cross et al., 1986). This would hence explain the absence of toughening. The mean WB shear value for each of the three cooked muscles was, in any case, lower than the values of 5.0-5.5 kgf reported by Shorthose et al. (1986), Chrystall (1988) and Lynch and Solomon (1988) as a level below which tenderness is satisfactory.

Conclusions

Rib-loin and leg of ram lambs roasted to 75 _C internal temperature differed as regards the extent of evaporative and drip loss, noticeably higher in the leg. As regards chemical composition of the cooked lean, the two cuts differed only for moisture and protein content, respectively lower and higher in leg than in rib-loin. While the degree of doneness of the cooked LTL, SM and BF was similar, as indicated by instrumental colour, cooking proceeded differently in the three muscles. As to extractable collagen and WB shear value, it would seem that LTL and SM had more in common with each other than with BF. This latter muscle underwent a more severe heat treatment and showed much smaller soluble collagen loss when compared to the other two, due to its shape and position in the leg. Besides the core position, it could be useful to monitor the temperature of more external portions of the cuts. This would give a better understanding of the effects produced by household cooking methods. It would be even more useful for larger cuts made up of a number of muscles.

References

AMSA (1978). Guidelines for cookery and sensory evaluation of meat. American Meat Science Association and National Live Stock & Meat Board, Chicago, USA, 24 pp.

AOAC (1990). Official Methods of Analysis. 15th ed. Association of Official Analytical Chemists, Washington, DC.

Bolink A.H., Visscher A.H., de Vries A.W. and Vonder G.M.A. (1990). IVO rapport B-364, Zeist, The Netherlands, 51 pp.

Chrystall B.B. (1988). Proc. 25th Meat Industry Research Conference, Hamilton, New Zealand, 41-45.

Cross H.R., Carpenter Z.L. and Smith G.C. (1973). J. Food Sci., 38: 998-1003.

Cross H.R., Durland P.R. and Seideman S.C. (1986). In: Bechtel P.J. (Ed.). Muscle as Food. Academic Press, Orlando, Chapter 7.

Dransfield E., Nute G.R., Hogg B.W. and Walters B.R. (1990). Anim. Prod., 50: 291-299.

EEC (1992). Reg. 2137/92, Off. Gaz. L214/1-5.

Folch J., Lees M. and Sloane Stanley G.H. (1957). J. Biol. Chem., 226: 497-509.

Grau R. and Hamm R. (1957). Zeitschr. für Lebens.-Untersuchung und-Forschung, 105: 446-460.

Griffin C.L., Savell J.W., Smith G.C., Rhee K.S. and Johnson H.K. (1985). J. Food Qual., 8: 69-79.

Hamm R. (1977). In: Høyem T. and Kvåle O. (Eds.). Physical, Chemical and Biological Changes in Food caused by Thermal Processing. Applied Science Publ., London, Chapter 7.

Hill F. (1966). J. Food Sci., 31: 161-166.

Jeremiah L.E. (1988). Can. Inst. Food Sci. Technol. J., 21: 471-476.

Jeremiah L.E., Tong A.K.W. and Gibson L.L. (1993). Proc. 39th Intern. Cong. Meat Sci. and Technol., Calgary, August 1-6, 1993, file S3P09.

Light N., Champion A.E., Voyle C. and Bailey A.J. (1985). Meat Sci., 13: 137-149.
Lynch G.P. and Solomon M.B. (1988). SID Research Journal, 5: 18-22.
Nakai H., Saito F., Ikeda T., Ando S. and Komatsu A. (1975). Bull. Nat. Inst. Animal Industry, 29: 69-74.
Paul P.C., McCrae S.E. and Hofferber L.M. (1973). J. Food Sci., 38: 66-68.
Sañudo C., Sierra I., Osorio M.T., Alcalde M.J., Santolaria P. and Alberti P. (1993). Proc. 39th Intern. Cong. Meat Science and Technol., Calgary, August 1-6, 1993, file S2P20.Shorthose W.R., Powell V.H. and Harris P.V. (1986). J. Food Sci., 51: 889-892, 928.
Solomon M.B., Kemp J.D., Moody W.G., Ely D.G. and Fox J.D. (1980). J. Anim. Sci., 51: 1102-1107.
StatSoft Inc. (1992). STATISTICA User's Guide - Tulsa, OK, USA.
Thatcher L.P. and Gaunt G.M. (1992). Aust. J. Agric. Res., 43: 819-830.
Woessner J.F. (1961). Arch. Biochem. Biophys., 93: 440-447.
Zondagh I.B., Holmes Z.A., Rowe K. and Schrumpf D.E. (1986). J. Food Sci., 51: 40-46.