EFFECT OF AGE AND FATNESS ON TENDERNESS OF BEEF CUTS IN SOUTH AFRICA

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SUMMARY

Electrically stimulated (500 V) beef carcasses, obtained from animals of three age groups and five fatness levels, were evaluated. The major muscles within the fifteen wholesale cuts (silverside: *M. semitendinosus* and *M. biceps femoris*) of the beef carcass were used to assess tenderness (sensory & shear force) and collagen (content & solubility) characteristics. Tender cuts, viz. prime rib, wing rib, loin, silverside (*M. semitendinosus*), rump, topside and fillet, were cooked by dry-heat, while the less tender part of the silverside (*M. biceps femoris*), thick flank, chuck, brisket, neck, shoulder, thin flank and hind and fore-shins according to a moist-heat method. All cuts were cooked at an oven temperature of 160 °C, to an internal temperature of 70 °C. Amongst other sensory quality characteristics the ten member, trained panel evaluated samples for tenderness, using an eight-point scale.

Tenderness and collagen solubility of all cuts decreased significantly with animal age. Animal age did not have a significant effect on collagen content of muscles. In general it would appear that carcass fatness had a significant, although not linear, effect on the various tenderness measurements. As expected, the tenderness characteristics of primal cuts within the same carcass varied considerably.

Introduction

Studies by numerous researchers (Hill, 1966; Bailey, 1972; Dutson, 1974; Shorthose & Harris, 1990) have consistently shown that as the physiological age of the animal advances tenderness decreases, due to the decreasing proportion of heat-labile collagen. Regarding the influence of carcass fatness on the eating quality of meat, Savell and Cross (1986) postulate that marbling could influence meat tenderness by decreasing the mass per unit volume when biting, by decreasing the thickness of the connective tissue membranes, by lubricating muscle fibres and fibrils, thus increasing sensation of tenderness, and by preventing dryness and toughness of too rapidly and extensively cooked meat. Varying degrees of expected tenderness and connective tissue content usually dictate the cooking method (dry or moist) for the different cuts (Ledward, 1979; Harris, 1976).

The South African beef carcass classification system incorporates two variables, namely age by dentition (indicating tenderness) and carcass fat cover class (indicating fatness and lean yield). Both variables were incorporated in this study, in order to elucidate their influence on the tenderness of the fifteen carcass cuts (London and Home Counties cuts, Meat Science Section, 1981), traditionally identified by industry as representative of the portioned carcass.

Materials and Methods

Carcasses (n=102) used in this study (190-240 kg) were from no specific breed, owing to the fact that in the South African classification system genotype is not identified. Only steers and heifers were selected due to the small proportion of bull carcasses presently on the market in South Africa. Carcasses obtained on the commercial market, were electrically stimulated (500 V) within 10 minutes of stunning, chilled overnight (0 to 5 °C) and transported to the IAPI in a refrigerated truck. The three age groups selected were 0 (no permanent incisors), 2 (permanent incisors) and 8-tooth. The five fatness classes, classified according to % carcass fat were: 10 (8 - 12% carcass fat), 14 (>12 - 16), 18 (>16 - 20), 22 (>20 - 24) and 26 (>24 - 28).

Sample preparation

Each of the 15 wholesale cuts of the right side were dissected into subcutaneous fat, meat and bone. Representative samples of 300 g of the minced subcutaneous fat plus meat tissue from each cut were analysed for percentage total moisture, fat, nitrogen (N x 6,25 = protein) and ash (A.O.A.C., 1985). Wholesale cuts of 41 left sides were vacuum-packaged and aged at 4 °C for 10 days post-slaughter. The major muscles of each cut were then dissected and vacuum-packaged until analysed (fresh) for collagen content and solubility. The remaining 61 left sides, which were used for sensory analysis and shear force measurements, were portioned into 15 wholesale cuts and trimmed further into retail cuts, the rump and topside being deboned before trimming. They were vacuum-packaged, aged at 4° C for 10 days post-slaughter and stored at -40 °C prior to preparation for sensory and shear force determinations. Cuts were defrosted at 6 - 8 °C for periods varying between 24 and 36 hours (depending on mass) until the internal temperature reached 2 - 5 °C (American Meat Science Association (AMSA), 1978).

Dry-heat cooking: The following cuts were used: Prime rib - 8 th to 10 th rib (*M. longissimus thoracis* (LTP)); Loin (*M. longissimus lumborum* (LL)); Wing rib - 11 th to 13 th rib (*M. longissimus thoracis* (LTW)); Rump (*M. gluteus medius* (GM)); Topside (*M. semimembranosus* (SM)); Silverside (*M. semitendinosus* (ST)) and Fillet (*M. psoas major* (PM)). All these cuts, excluding the loin, were cooked in primal form. The cuts were roasted whole at 160 °C, on a rack in an open oven pan, until the muscle to be evaluated reached an internal temperature of 70 °C. The loin cuts were portioned into beef steak retail cuts of 25 mm thickness (AMSA, 1978) vacuum- packaged and stored at -40 °C. Defrosted steaks were cooked according to an oven-broiling method whereby the meat is cooked by direct radiant heat (> 200 °C) to an internal temperature of 70 °C.

Moist-heat cooking: The following cuts (muscles) were used: Silverside (*M. biceps femoris*), Thick flank (*M. vastus lateralis*), Chuck (*M. serratus ventralis*), Brisket (*M. pectoralis profundus*), Neck (*M. biventer cervicis*), Shoulder (*M. triceps brachii caput longum*), Thin flank (*M. obliquus abdominis externus*) and shins (*M. extensor carpi radialis* and *M. flexor digiti I longus*) (Weniger, Steinhauf & Pahl, 1963). The silverside, thick flank, chuck, shoulder and neck were cooked in primal form. The brisket and thin flank were trimmed before ageing, formed into a meat roll and covered with mesh. Before cooking commenced, the frozen fore and hind-shins were portioned into beef retail cuts of 5 cm thickness. The cuts were broiled at 160 °C, on a rack in a covered stainless steel casserole dish, until the muscle to be evaluated reached an internal temperature of 70 °C. A 100 ml of distilled water at room temperature was added to each dish before cooking commenced.

Descriptive palatability attributes

A ten-member, trained, descriptive attribute panel was used to evaluate palatability attributes of each cut. Panellists were selected and trained in accordance with the AMSA Guidelines for Cooking and Sensory Evaluation of Meat (AMSA, 1978) and the procedures of Cross, Moen and Stanfield (1978). Samples (1 cm^2) were evaluated for tenderness on an 8-point scale ("one" denoting the least favourable condition and an "eight" the most favourable).

Shear force determination

Shear force was measured as the maximum force (Newtons) required to shear a cylindrical core of cooked muscle perpendicular to the grain, at a crosshead speed of 400 mm per second. The shear force measurements were generated with a Warner Bratzler shear attachment, fitted to an Instron Universal Testing Machine Model 1140 (Instron Food Testing Instrument, 1974). Cylindrical cores were cut from all the muscles (using a standard 25 mm diameter bore) except for the loin and brisket (where a 13 mm bore was used) and the thin flank (for which a cherry-pipper attachment was used). These exceptions were due to the shape and size of these cuts.

Collagen content and solubility

The total collagen content of each of the respective muscles was determined according to the method of Weber (1973) and hydroxyproline according to Bergman and Loxley (1963). Total collagen content was calculated as the ratio of hydroxyproline nitrogen relative to the total nitrogen content, expressed as a numeric value multiplied by 1 000 (Boccard, Naudé, Cronjé, Smit, Venter & Rossouw, 1979). Collagen solubility was determined according to a combination of the methods of Hill (1966) and Bergman and Loxley (1963), being expressed as hydroxyproline content of the filtrate as a percentage of total hydroxyproline (filtrate plus residue).

Results and Discussion

Age of the animal had a significant effect on the tenderness, shear force and collagen solubility of various cuts. According to the taste panel scores 11 of the 15 cuts of the 0-tooth age group were significantly ($P \leq 0,05$) more tender than those from the 2-tooth age group. For 8-tooth all 15 cuts were significantly ($P \leq 0,05$) less tender than those from the 2-tooth age group (Table 1).

The collagen solubility of 12 of the 16 cuts measured were significantly ($P \leq 0,05$) more soluble in cuts obtained from the 0-tooth age group compared to those from the 2-tooth age group. The collagen of all 16 cuts measured of the 0-tooth age group were significantly ($P \leq 0,05$) more soluble than those from the 8-tooth age group (Table 2).

Apparently, fatness of the carcass had a significant, although not linear, effect on the various tenderness measurements. The exact influence of fatness on tenderness is still not known. Further investigation is essential (Table 1).

Conclusion

In this study it was conclusively demonstrated that the age and fatness (to a lesser extent) of beef cattle influence meat tenderness significantly. Age showed a negative and fatness a positive relationship with tenderness.

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