

CHANGES IN MYOFIBRILLAR/CYTOSKELETAL PROTEINS OF BOVINE LONGISSIMUS MUSCLES OFFERING IN TENDERNESS

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SUMMARY:

Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) was used to detect changes in the high molecular weight proteins, titin and nebulin, and lower molecular weight proteins. Purified myofibrils were prepared from strip loin steaks postmortem aged for varying lengths of time from bulls, cows and steers. Increasing postmortem aging time was accompanied by loss of the T₁ band of titin. The T₁ band persisted longer in steaks from cows. Nebulin was observed more frequently in steaks from carcasses of bulls and in less tender steaks from steers and cows. Proteolysis of these two large structural proteins seems to be of significance in beef steak tenderization.

INTRODUCTION:

Changes in the myofibrillar proteins have been shown to be related to changes in beef steak tenderness (Parrish et al., 1973; Olson et al., 1976; MacBride and Parrish, 1977). The fragmentation of the myofibril at or near the Z line and the production of the 30,000 dalton component coincide with improved tenderness (Olson et al., 1976; Olson and Parrish, 1977; Olson et al., 1977). Indeed, the myofibril fragmentation index accounts for about 50 percent of variation in beef loin steak tenderness (Olson and Parrish, 1977). More recently our work on the postmortem degradation of titin and nebulin indicates that their degradation is related to beef steak tenderization (Paterson and Parrish, 1987; Anderson and Parrish, 1989).

The objective of this study was to examine the effects of animal age and sex and postmortem aging on the degradation of titin and nebulin in bovine longissimus dorsi muscle.

MATERIALS AND METHODS:

Strip loins were obtained from the carcasses of ten bullocks, ten steers (\approx 14 months of age) and ten cows (44 - 108 months of age). Strip loins were removed from carcasses at approximately twenty-four hours postmortem. Each of the thirty strip loins were individually vacuum packaged and stored at 2°C. Two 2.86 cm steaks and two 1.27 cm steaks were removed from each strip loin at three, seven, fourteen and twenty-eight days postmortem, vacuum packaged, frozen and stored at -20°C until analysis. Sensory attributes and Warner-Bratzler shear force values were determined on steaks broiled to an internal temperature of 65°C.

Purified myofibrils used for analysis by SDS-PAGE were isolated from raw samples taken from 1.27 cm thick steaks adjacent to the 2.86 cm thick steaks of each sex and age category at the four postmortem aging periods by using a modification of the method by Lusby et al. (1983).

SDS-PAGE was done according to the procedure of Laemmli (1970) with modifications to accommodate separation of proteins with widely different molecular weights. A 5% polyacrylamide (acrylamide/bisacrylamide = 100:1, w/w) slab gel was used to monitor changes in extremely high molecular weight proteins (e.g., titin and nebulin) and a 12% polyacrylamide (acrylamide/bisacrylamide = 37:1, w/w) slab gel, with a 5% polyacrylamide stacking gel, was used to monitor changes in lower molecular weight myofibrillar/cytoskeletal proteins.

RESULTS AND DISCUSSION:

Figure 1 of a 12% SDS-PAGE electrophoretogram shows that in the more tender sample at day 3 postmortem, the 30,000-dalton component band is faintly present, while at days 3 and 7 postmortem in the more tough sample, the 30,000-dalton component band is not yet observed. The greatest increase in intensity of the 30,000-dalton component seemed to coincide with the largest reduction in shear force values and the largest increase in sensory panel determinations of fiber fragmentation. The 30,000-dalton component was observed, however, to have appeared in all samples in this study by 28 days postmortem.

Figure 2 of a 5% SDS-PAGE electrophoretogram shows that increasing time postmortem was accompanied by a loss of the T₁ band of titin (upper band) and by a loss of the nebulin band. The T₁ band disappeared earlier in tender steaks. Increased intensity of the T₂ band seems to indicate breakdown of titin into slightly lower molecular weight components. Less nebulin was seen in tender steaks at 3 days postmortem. At 7 days postmortem or later, nebulin was not present in tender or less tender steaks from bulls, steers, and cows.

Figure 3 of a 5% SDS-PAGE electrophoretogram shows that a nebulin band was consistently present in samples from bulls (lanes 4, 5, 6) and older animals (cows, lanes 7, 8, 9), while it was not always present at day 3 postmortem in samples from steers (lanes 1, 2, 3).

Figure 4 of a 5% SDS-PAGE electrophoretogram shows the T₁ band of titin more frequently at 14 days postmortem in samples from older animals (cows, lanes 7, 8, 9) than in samples from steers and bulls (lanes 1 through 6). The samples from older animals (cows, lanes 7, 8, 9) also had the heaviest T₂ bands (lower bands).

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Figure 1. 12% SDS-PAGE gel of purified myofibrils from "tough" and "tender" longissimus samples from two steer carcasses over all postmortem aging times

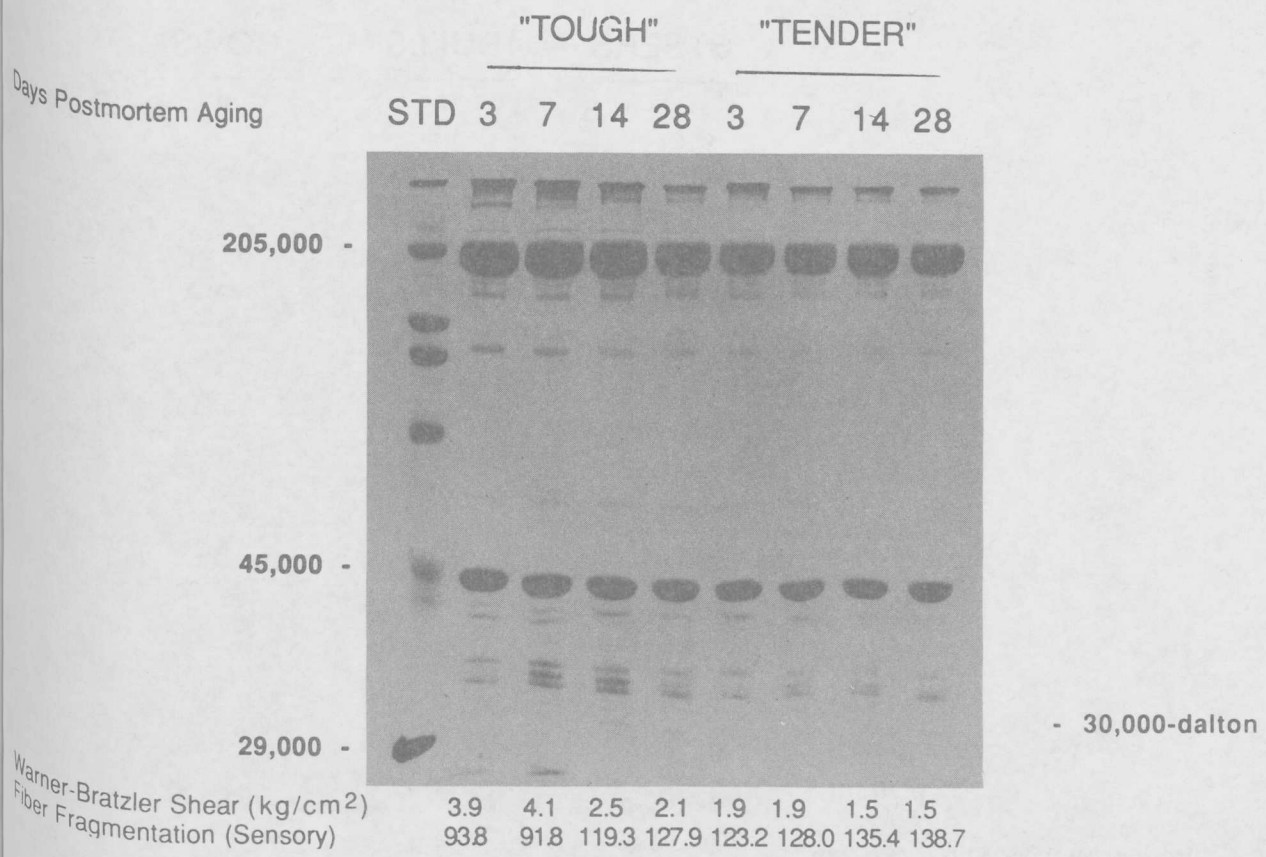


Figure 2. 5% SDS-PAGE gel of purified myofibrils from "tough" and "tender" longissimus samples from two steer carcasses over all postmortem aging times



Figure 3. 5% SDS-PAGE gel of purified myofibrils from longissimus samples from carcasses of bulls, steers and older animals (cows) at 3 days postmortem

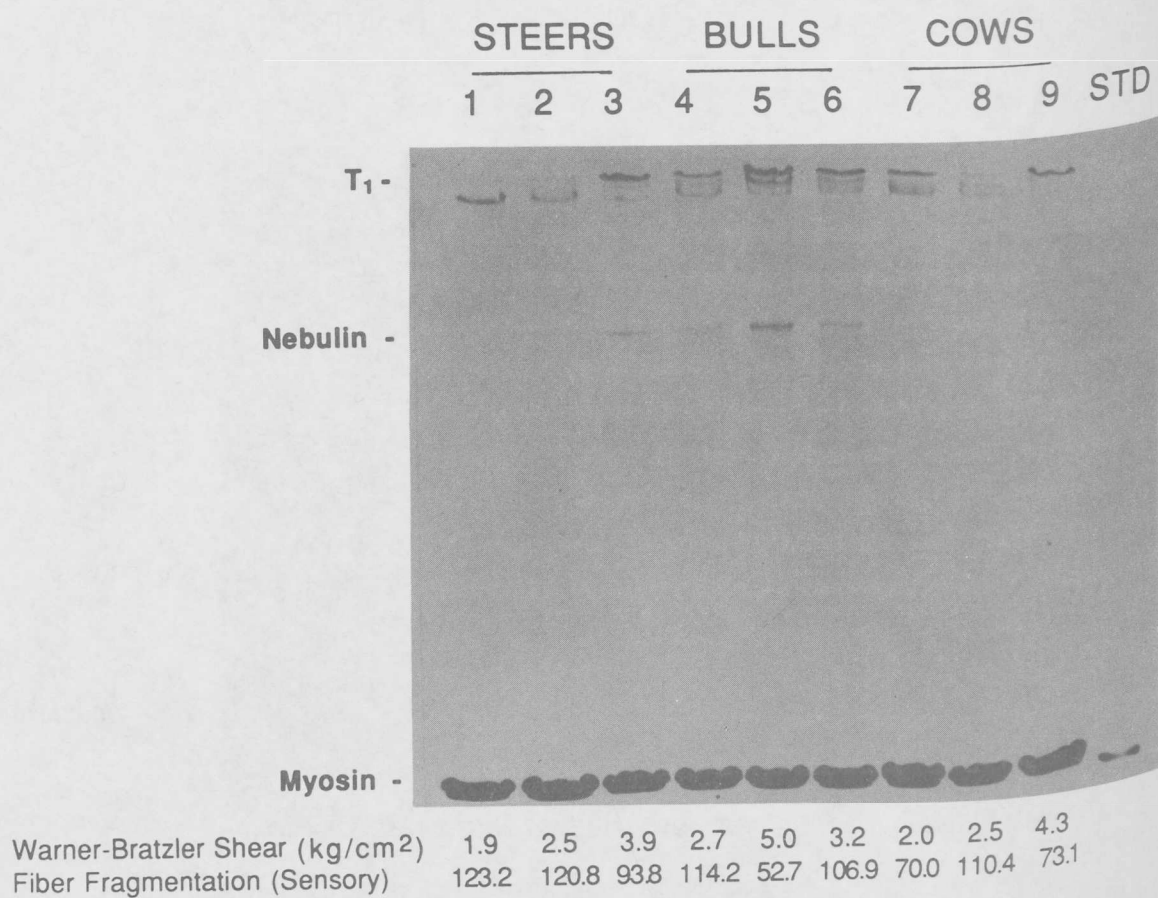


Figure 4. 5% SDS-PAGE gel of purified myofibrils from longissimus samples from carcasses of bulls, steers and older animals (cows) at 14 days postmortem

