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POST-MORTEM PROCESSING PROCEDURES TO TENDERIZE CALLIPYGE LAMB

CHARLES E. CARPENTER, PHD[1] AND MORSE SOLOMON, PHD[2]
[1]Dept. Nutrition and Food Sciences, Utah State University, Logan, Ut 84322-8700
[2]Meat Science Research Laboratory, USDA, ARS, Beltsville, Md 20705

INTRODUCTION: Inherited muscle hypertrophy in sheep is associated with the callipyge gene located on ovine chromosome 18 [1]. The important economic benefits of muscle hypertrophy are manifold and include increased size of the muscles of the loin and leg, leaner carcasses, and increased feed efficiency [2-5]. Unfortunately, there is a negative aspect in that the meat from callipyge animals tends to be tough [3, 6]. Aging is the traditional method of improving meat tenderness, while electrical stimulation (ES) and calcium infusion (CI) are newer post slaughter technologies for improving tenderness of meat. Experiment 1 determined which of these treatments (alone or in combination) provided the most tender normal and callipyge loin chops after different periods of aging. Experiment 2 compared the sensory characteristics of normal chops with callipyge+ES+CI chops, which were the most tender of the callipyge chops.

MATERIALS AND METHODS: In Experiment 1, 22 normal and 16 callipyge lambs were slaughtered at 51 - 55 kg live weight. One half the normal (11) and the callipyge (8) carcasses were stimulated immediately after slaughter using a RMS stimulation voltage (rectangular wave) of 21 V, 60 Hz, 0.25 amps alternating current. Stimulation was applied for a total duration of two minutes in impulses of 20 sec and allowing the carcass to relax between impulses. After stimulation, the carcasses were conditioned at 27° C until pH < 6.0 was obtained in the longissimus muscle, which was usually within 1 hr after stimulation The loins from all animals were removed at 24 hours post mortem. One loin from each carcass was injected with a solution of 0.3% calcium chloride to 10% of the fresh loin weight. After a 4 hr equilibration period, 2 chops (1.90 cm thick) were removed from the posterior end of each loin, wrapped, and stored frozen at -34° C. The remainder of each loin was divided into 3 equal segments and stored vacuum packaged at 2° C until 8, 15, or 22 days post mortem. Equal numbers of each loin segment (anterior to posterior) were assigned to each of the aging periods so that loin position was not a confounding factor. At the end of the aging period, 2 chops were cut from each loin section. The chops were wrapped and stored frozen at -34° C. Chops were grilled to 71° C internal temperature and shear values taken on 1.27 cm cores. Experiment 2 compared the sensory characteristics of untreated normal chops and callipyge+ES+CI chops from an additional 10 normal and 10 callipyge lambs.

RESULTS AND DISCUSSION: The results of experiment 1 are presented Figures 1-3 and in Table 1. Aging decreased the shear of both normal and callipyge chops (Table 1). This is expected for most muscles, largely as the result of tenderization due to proteolysis of the myofibrils by the calpains, a family of calcium-activated proteases [7, 8]. However, aging does not tenderize the hypertrophied muscles from β-agonist fed lambs [9, 10], which may be due to the higher levels of calpastatin in these muscles [11].

Electrical stimulation tended to increase the shear of normal chops, but had no effect on callipyge chops (Table 1). Although ES is generally associated with tenderizing effect, it can also toughen or have no effect depending on the source of stimulation (e.g., voltage, use of a conditioning period, etc.) and the muscle characteristics (e.g., fiber type composition, location on the carcass, etc.) [11, 12]. In general, ES tenderizes meat by preventing cold shortening, but this must be weighed against the possibility of toughening due to rigor shortening [11, 13]. ES induces more rigor shortening in oxidative muscles than in glycolytic muscles [14]. Since normal longissimus muscle has more oxidative fibers than does callipyge longissimus muscle [15], ES may have toughened normal chops by increasing rigor shortening.

CI did not effect shear values in either normal or callipyge chops (Table 1), indicating that the activity of the calcium-activated proteolytic system was not increased by infusion of calcium. This was unexpected since CI generally improves meat tenderness, even in β-agonist fed lambs [9]. However, CI decreased shear values in both normal and callipyge chops after ES of the carcasses. This indicated that ES had altered the calcium-activated proteolytic system. For example, ES and conditioning produces early postmortem conditions that activate calpain I [16], which is capable of degrading calpastatin [7, 17]. Thus, levels of calpastatin may be decreased by ES, which, in turn, would allow greater activation of calpain II after calcium infusion.

Untreated chops tended to be the most tender of the normal chops after 15 days of aging (Fig. 1), while ES+CI chops tended to be the most tender of the callipyge chops (Fig. 2). In comparison, however, the callipyge+ES+CI chops had about 1 kg greater shear than normal chops after all aging times (Fig. 3). This indicated that postmortem proteolytic activity was similar in normal and callipyge+ES+CI chops, but that they differed in another morphological quality related to tenderness such as degree of shortening of the sarcomeres [14], type and content of connective tissues [18, 19], or compactness of the muscles structure (i.e., more protein and less fat)[20]. As compared to normal longissimus muscle, we do know that callipyge longissimus muscle has considerably larger fast twitch fibers [15], higher concentration of protein, and lower concentration of fat (unpublished observations). The aging curves (Fig. 3) for callipyge+ES+CI and normal chops were quite parallel, indicating similar rates of postmortem tenderization. Tenderization of chops continued through 15 days of aging, suggesting a prolonged period of active tenderization as compared to the 5 - 7 days of active tenderization reported for lamb [21, 22]. Nevertheless, shear values after 15 days of aging were 2.25 ± .27 kg (mean ± SEM) for normal

chops and 3.16 ± .42 kg for callipyge+ES+CI chops, which were similar to the 2.5 - 3 kg values reported for cooked lamb longissimus muscle [21, 22].

Sensory analysis (Table 2) indicated that the callipyge+ES+CI chops had acceptable texture, flavor, and juiciness. However, callipyge+ES+CI chops had lower scores than normal chops for texture, flavor, and juiciness, agreeing with the results of Jackson et al. [3]. Thus, ES+CI produced chops with acceptable sensory attributes, although not as desirable as normal chops. The lower juiciness and flavor scores of callipyge chops may be due to the lower fat concentrations in callipyge longissimus (unpublished observation). The reason for lower tenderness scores in callipyge chops is not clear.

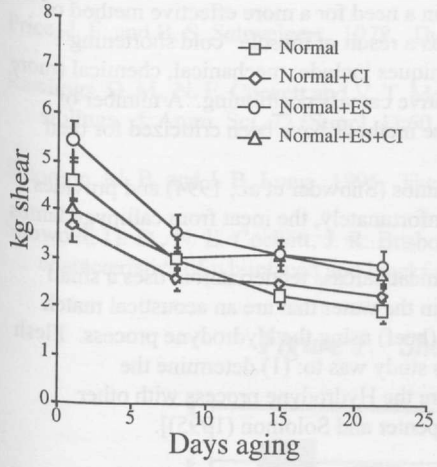

Figure 1. Effect of aging at 2° C on the shear values of loin chops from normal lambs. Treatments included low voltage electrical stimulation of the carcasses (ES) and/or calcium infusion (CI) into the loins. Values are means ± SEM, n=11.

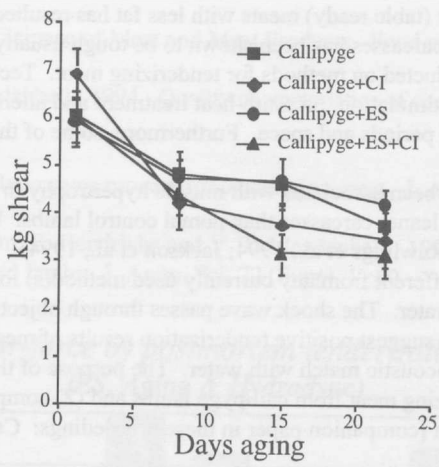

Figure 2. Effect of aging at 2° C on the shear values of loin chops from callipyge lamb. Treatments included low voltage electrical stimulation of the carcasses (ES) and/or calcium infusion (CI) into the loins. Values are means ± SEM, n=8.

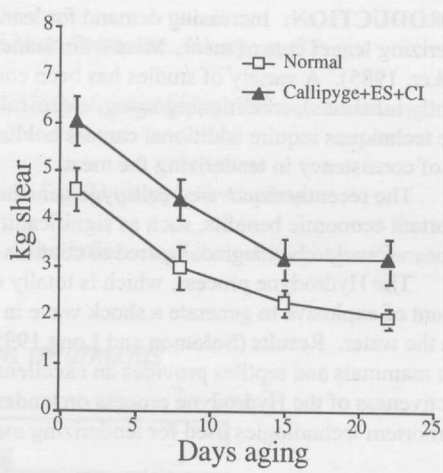

Figure 3. Effect of aging at 2° C on the shear values of loin chops from normal (n=11) and callipyge (n=8) lambs. Callipyge carcasses were treated with low voltage electrical stimulation (ES) and calcium was infused (CI) into the loins. Values are means ± SEM.

Table 1. Treatment effects on shear of lamb loin chops.

Phenotype of sheep and Treatment	Effect of treatment
Normal lambs	
Aging	Decreased shear (p<0.001)
Electrical stimulation	Increased shear (p=0.069)
Calcium infusion	
- w/o electrical stimulation	No effect on shear (p=0.431)
- after electrical stimulation	Decreased shear (p=0.019)
Callipyge lambs	
Aging	Decreased shear (p<0.001)
Electrical stimulation	No effect on shear (p=0.704)
Calcium infusion	
- w/o electrical stimulation	No effect on shear (p=0.507)
- after electrical stimulation	Decreased shear (p=0.039)

Tale 2. Sensory scores of lamb loin chops[1].

Sensory attribute	callipyge +ES+CI	normal	significance (p value)
Texture	6.3 ± 1.8	7.1 ± 1.5	.001
Flavor	6.5 ± 1.7	6.9 ± 1.7	.002
Juiciness	6.3 ± 1.6	7.2 ± 1.4	.001

[1]Values are means ± SD. Sensory scores were on a hedonic scale where 1=dislike extremely, 5=neither like nor dislike, and 9=like extremely

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