E40

TENDERIZING CALLIPYGE LAMB WITH THE HYDRODYNE® PROCESS

MORSE B. SOLOMON[1], JOHN B. LONG[2], JANET S. EASTRIDGE[1] AND CHARLES E. CARPENTER[3]
[1]Meat Science Research Laboratory, USDA, ARS, Beltsville, MD 20705, USA
[2]John Long and Associates, Sarasota, FL 34263, USA
[3]Dept. of Nutrition and Food Sciences, Utah State University, Logan, UT 84322, USA

Key Words: Callipyge Lamb, Meat, Tenderization Techniques

INTRODUCTION: Increasing demand for leaner (table ready) meats with less fat has resulted in a need for a more effective method of tenderizing leaner cuts of meat. Meat from leaner carcasses has been shown to be tough usually as a result of muscle "cold shortening" (Locker, 1985). A variety of studies has been conducted on methods for tenderizing meat. Techniques include: mechanical, chemical (more recently infusions), conditioning/aging, electrical stimulation, pressure-heat treatment and alternative carcass positioning. A number of these techniques require additional carcass holding periods and space. Furthermore, some of these methods have been criticized for their lack of consistency in tenderizing the meat.

The recently discovered callipyge gene has been associated with muscle hypertrophy in lambs (Snowder et al., 1994) and provides important economic benefits, such as significantly leaner carcasses than nomal control lambs. Unfortunately, the meat from callipyge lambs has been found to be tough compared to controls (Rawlings et al., 1994; Jackson et al., 1994).

The Hydrodyne process, which is totally different from any currently used method(s) for meat/carcass tenderization, uses a small amount of explosive to generate a shock wave in water. The shock wave passes through objects in the water that are an acoustical match with the water. Results (Solomon and Long,1995) suggest positive tenderization results of meat (beef) using the Hydrodyne process. Flesh from mammals and reptiles provides an excellent acoustic match with water. The purpose of this study was to: (1) determine the effectiveness of the Hydrodyne process on tenderizing meat from callipyge lambs and (2) compare the Hydrodyne process with other postmortem technologies used for tenderizing meat [companion paper in these proceedings: Carpenter and Solomon (1995)].

MATERIALS AND METHODS: Six callipyge lambs and one normal, control lamb from Experiment 1 of Carpenter and Solomon (1995) which were slaughtered at approximately 62 kg live weight were used in the present study. These seven carcasses were chosen based on their Warner-Bratzler shear-force values (longissimus muscle = LM) after one day of aging (baseline-initial shear-force). The average shear-force was 7.0 kg (ranging from 9.4 to 5.2 kg). LM (rack) samples for the Hydrodyne process were removed (1-3 d postmortem) from each carcass and wrapped, frozen and stored at -34° C. These LM samples corresponded to the loin LM samples utilized in the companion study (Carpenter and Solomon, 1995). Those carcasses either received 21 V (rectangular wave), 60 Hz, 0.25 amps alternating current (electrical stimulation) immediately after slaughter or no stimulation. Stimulated carcasses were conditioned at 27° C until pH < 6.0 was obtained in the LM (reached within 1 h). The loin LM samples from Carpenter and Solomon (1995) also received additional postmortem tenderization procedures. This included 8, 15 or 22 d of aging (2° C) postmortem or a 0.3% injection of calcium chloride to 10% of the fresh muscle weight coupled with postmortem aging of 8, 15 or 22 d (2° C). For complete details see Carpenter and Solomon (1995) in these proceedings.

The Hydrodyne process involved a small amount of explosive (100 g) to generate a shock wave in water. The pressure front of this wave was approximately 10,000 psi at the contact surface with the meat. The meat was encapsulated twice, once in a cryovac bag that was oxygen impermeable and then these bags were,in turn, placed in a rubber bag. Both bags were evacuated. The explosive used was composed of a liquid and a solid, neither of which are explosives until combined. The force of the explosion was contained in 208 liter container which was situated below ground level.

RESULTS AND DISCUSSION: Results of the Hydrodyne process compared to the other postmortem processing procedures used to tenderize the LM samples in the Carpenter and Solomon (1995) study are presented in Figures 1 and 2. Callipyge LM samples (n=6) treated with the Hydrodyne process yielded shear values of 4.6 kg. This resulted in a 42% improvement from day one electrically stimulated callipyge carcasses (4.6 vs. 7.8 kg) and a 30% improvement from day one non-stimulated callipyge carcasses (4.6 vs. 6.6 kg). The Hydrodyne process also improved shear-force values by 38% in the normal, non-callipyge control lamb (4.1 vs. 6.6 kg).

The Hydrodyne process, which is totally different from any tenderizing system currently in use, uses a small amount of explosive to generate a shock wave in water. The shock wave passes through objects (meat) in the water that are an acoustical match with water. The shock wave reflects off any object in the water that is not an acoustic match. To be an acoustic match with water, the object must possess a ratio of E/D similar to water, where E is the bulk modulus of elasticity and D is the density. Meat (muscle) which compositionally is approximatly 75% water depending on the amount of intramuscular fat present (Price and Schweigert, 1978) is a close acoustical match. Uniformity of tenderization is achieved by supporting the meat against a steel surface and reflecting the shock wave back to intersect the incoming wave. The Hydrodyne process occurs in fractions of a millisecond. When the shock wave passes through the meat, a compression occurs in advance of the wave front, and negative pressure or rarefaction occurs after its passage. If the shock pressure is large enough the results are a tenderizing effect. As observed in Figure 1, the Hydrodyne process was very successful in tenderizing LM lamb chops from callipyge and normal lamb.

Aging (8-22 d) and aging in combination with calcium chloride infusion decreased shear values for both callipyge and normal lamb chops (Figures 1 and 2). Shear values from both callipyge and normal lamb chops (pooled) treated with the Hydrodyne process compared favorably with postmortem aging (22 d) (4.6 vs. 4.5 kg) and aging (22 d) in combination with calcium chloride infusion treatment (4.6 vs. 4.3 kg). When energy, space and labor costs are considered for aging meat with or without additional postmortem tenderization treatments, a major savings can be realized using the Hydrodyne process as an alternative method. The Hydrodyne process is quite different from other existing tenderizing techniques. Results suggest that tenderizing meat with an explosively generated shock wave pressure front in water (Hydrodyne) presents a potentially revolutionary change in the way the meat industry can tenderize meat and save on energy, space, and labor costs.

REFERENCES:

Carpenter, C. E. and M. B. Solomon. 1995. Post-mortem processing procedures to tenderize callipyge lambs. ICoMST Proceedings.

Jackson, S. P., C. R. Kerth, M. F. Miller and R. D. Green. 1994. Palatability of muscle from ram and wether lambs expressing the callipyge gene. J. Anim. Sci. 72 (Suppl. 1):60.

Locker, R. H. 1985. Cold-induced toughness of meat. In Advances in Meat Research, Vol. 1, Electrical Stimulation (A. M. Pearson and T. R. Dutson, eds.) pp. 1-44, Van Nostrand Reinhold/AVI, New York.

Price, J. F. and B. S. Schweigert. 1978. The Science of Meat and Meat Products. Food and Nutr. Press, Inc., Westport, CT.

Rawlings, D. M., N. E. Cockett and V. T. Mendenhall. 1994. Quality characteristics of cooked lamb from callipyge animals and normal half-siblings. J. Anim. Sci. 72 (Suppl. 1):60.

Solomon, M. B. and J. B. Long. 1995. The Hydrodyne process for tenderizing meat. J. Anim. Sci. 73 (Suppl. 1): In press.

Snowder, G. D., N. E. Cockett, J. R. Busboom, F. Hendricks and V. T. Mendenhall. 1994. The influence of the callipyge gene on carcass characteristics of whitefaced and blackfaced lambs. J. Anim. Sci. 72 (Suppl. 1):60.

Figure 1. Shear-force by postmortem tenderization treatments (ES, Aging & Hydrodyne)

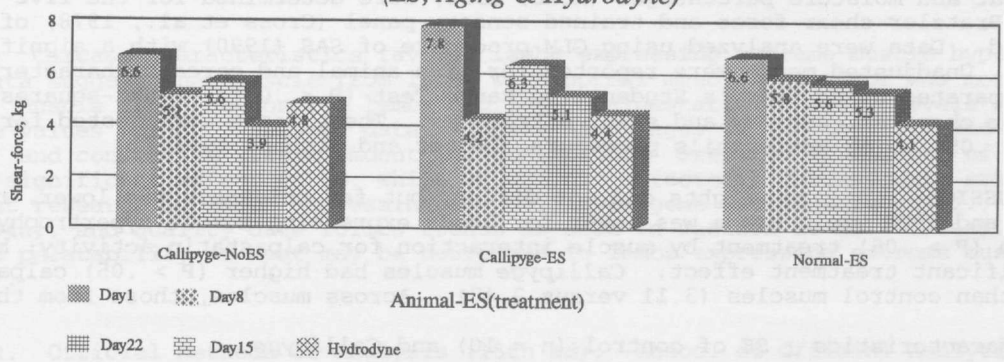

Figure 2. Shear-force by postmortem tenderization treatments (ES, CaCl-Aging & Hydrodyne)