

# Tenderization of Caprine Carcasses with Injection of Calcium Chloride

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## ABSTRACT

This study evaluated the effects of calcium chloride ( $\text{CaCl}_2$ ) on the tenderness of caprine meat. Data from nine Spanish goats (*Capra hircus*) were evaluated to determine tenderness using shear force values and sensory evaluation. The longissimus muscle (LD) and psoas major (PM) were removed immediately after slaughter, and 0.2 M of  $\text{CaCl}_2$  was injected into each at the rate of  $0.1 \text{ ml g}^{-1}$  ( $0.1 \text{ pints lb}^{-1}$ ). Samples were heat-seal packaged and tumbled for 2 hours. Samples were then placed in the cooler and aged for 48 hours. After freezer storage, the meat was thawed and the LD was cut into 1-inch steaks starting from the posterior end. Three 0.5-inch cores were taken from each steak and sheared once. The PM was left whole and three 0.5-inch cores were taken and sheared once. Warner-Bratzler shear force and sensory evaluations were conducted. A significant difference ( $P < 0.05$ ) in shear force was found in the LD meat. Sensory evaluations for tenderness expressed panelists' ability to detect a difference between treatments and preferences ( $P < 0.05$ ) for meat injected with  $\text{CaCl}_2$ .

KEYWORDS: goat, meat

Because palatability is a major concern of consumers purchasing meat products, producers are constantly searching for new ways to improve meat tenderness. Recently, it was shown that lamb and beef carcasses can be tenderized by the infusion of  $\text{CaCl}_2$  (Koochmaraie et al., 1989; Koomaraie et al., 1990). Although this method has been effective in lamb and beef carcasses (Koochmaraie et al., 1991), it has yet to be studied with caprine carcasses. In addition, no research has been conducted using injection and tumbling of meat as a means to disperse  $\text{CaCl}_2$  throughout the meat. If proven to be effective, this may be a practical way to disperse  $\text{CaCl}_2$  and increase the marketability (tenderness) of Spanish goats.

The terms "Spanish goat" and "brush goat" refer to goats that are mongrel animals descended from most of the major milk goats (Ensminger and Parker, 1986). These goats come in a variety of colors and patterns. Both males and females have horns, a few being polled.

Spanish goats are known for their ability to exist largely upon brush and still yield acceptable quantities of edible meat (Dollahite, 1972). Goat meat is similar in nutritive value to beef and lamb, but contains less fat (Ensminger and Parker, 1986).

The purpose of this study was to show that the combined effect of a  $\text{CaCl}_2$  (0.2 M

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solution) injection and the tumbling of caprine meat immediately after slaughter will result in postmortem tenderization.

## METHODS AND MATERIALS

This research was conducted at the Sul Ross State University Meat Science Laboratory in Alpine, Texas. For this experiment, nine Spanish goats were on feed for 5 months (dry lot), then slaughtered (10 to 14 months of age, 86 to 155 lbs.). Immediately after slaughter, the longissimus muscle (LD) and the psoas major (PM) were removed, weighed and then injected with a 0.2 M solution of calcium chloride at the rate of 0.1 ml g<sup>-1</sup> (0.1 pint lb<sup>-1</sup>). Additives used in this study for injection were food grade calcium chloride (CaCl<sub>2</sub>) and distilled water (H<sub>2</sub>O).

The LD and the PM were removed from each side of the fresh carcasses. The pair from the right side was designated as the control and the pair from the left side as the treatment. Both groups were weighed, and a 0.2 M solution of CaCl<sub>2</sub> was injected into the treatment pair. Muscles were sealed into nonvacuum plastic bags and tumbled for 2 hours in the cooler at 42°F. At the end of the tumbling period, both groups were stored in the cooler for 48 hours and then transferred to the freezer (-10°F).

The LD and PM were removed from the freezer and thawed for 24 hours at 42°F. Each LD was sliced from the posterior end into 1-inch steaks. The PM were left whole. The meat was cooked in a preheated (350°F) Blodgett Type CTB-1 convection oven. All samples were cooked to an internal temperature of 150°F before being removed.

For sensory evaluation, a seven-member trained sensory panel (Gross and Stanfield, 1976) evaluated broiled caprine meat steaks. The panelists evaluated the steaks for tenderness at room temperature. A 6-point scale (6=highly acceptable and 1=highly unacceptable) was used in evaluating the product tenderness.

A mechanically powered Warner-Bratzler Shear was used to objectively measure tenderness. Shear force was estimated with steaks from the control and experimental groups. After cooking, 0.5-inch cores were taken. From each LD steak, four cores were taken with a hand-held coring device. From each PM, three cores were taken. Each core was sheared once.

A paired t distribution (Zar, 1984) analysis was used to determine significant differences ( $P < 0.05$ ) between means for shear values. The Duo-Trio Differentiation test was analyzed based on the number of correct responses compared to the total number of responses (Stone and Sidel, 1985). A chi-square analysis (Zar, 1984) was used to determine significant differences ( $P < 0.05$ ) between means for the taste panel ratings. The data were analyzed using the SPSS (1988) implementation of the paired t distribution and chi-square analyses.

## RESULTS AND DISCUSSION

### Shear Force

Results of the paired t distribution analysis showed a significant difference ( $P < 0.05$ ) in the shear-force values between the control and the treatment groups of

the LD (Table 1). Lowered shear-force values indicated an increase in tenderness of the injected samples. The analysis of the PM (Table 2) showed significance ( $P < 0.05$ ), with the control being more tender than the injected. However, in the PM this significance is of little practical importance to consumers as the muscle is naturally tender without treatment. St. Angelo (1991) reported that when lamb carcasses are infused with 0.3 M  $\text{CaCl}_2$  mechanical shear-force measurements are significantly reduced when compared to control lambs. In addition, it has been shown (Boleman et al., 1993) that a 0.3 M solution of  $\text{CaCl}_2$  at 10% by weight 1-hour postmortem is effective in lowering shear-force values.

Table 1. Paired t test table of shear force values for 0.2 M  $\text{CaCl}_2$  injected and non-injected (control) meat of the longissimus muscle.

Treatment	Number of pairs	DF	Mean (lb) $\pm$ SD	SE of Mean	2-tail Sig.
0.2 M $\text{CaCl}_2$	108	107	7.9602 $\pm$ 2.4190	.233	.0001
Control			10.7991 $\pm$ 2.6410		

Table 2. Paired t test table of shear force values for 0.2 M  $\text{CaCl}_2$  injected and non-injected (control) meat of the psoas major.

Treatment	Number of pairs	DF	Mean (lb) $\pm$ SD	SE of Mean	2-tail Sig.
0.2 M $\text{CaCl}_2$	36	35	5.0333 $\pm$ 2.0540	.342	.027
Control			4.1833 $\pm$ 1.4710		

### Sensory Evaluation

In the analysis of the Duo-Trio Differentiation test, there were 47 correct responses out of 63. Upon analysis of data, a highly significant difference ( $P < 0.001$ ) in treatments was found. This indicated that panelists were able to detect a difference between  $\text{CaCl}_2$  injected meat and non-injected LD meat.

Results of the chi-square analysis (Table 3) of the tenderness ratings showed a significant difference ( $P < 0.05$ ). Seventy-six percent of the panelists rated the  $\text{CaCl}_2$  injected meat as slightly acceptable or above, compared to the non-injected meat where 51% was rated as slightly acceptable or above.

Table 3. Chi-square analysis<sup>†</sup> for taste panel acceptance in LD muscle.

Treatment	Rating <sup>‡</sup>					
	1	2	3	4	5	6
0.2 M $\text{CaCl}_2$	1	3	11	15	23	10
Control	1	10	20	14	11	7

<sup>†</sup>Chi-square likelihood ratio = 11.5; df = 5; P-value = 0.042.

<sup>‡</sup>Ratings: 1 = highly unacceptable and 6 = highly acceptable.

### CONCLUSION

The injection of  $\text{CaCl}_2$  in the LD of Spanish goats had an effect on tenderness when compared to meat containing no  $\text{CaCl}_2$ . Shear force values were reduced in the LD and sensory panel acceptability was increased.

This study indicates that successful tenderization of Spanish goat meat can be increased significantly when  $\text{CaCl}_2$  is injected and tumbled postmortem. Thus, it is believed that the potential marketability of this product may be enhanced through a more rapid method of tenderization prior to the onset of rigor mortis. This finding will enable the Spanish goat industry to guarantee a tender and calcium-fortified product.

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