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Improvement of Pork Loin Tenderness Using the Hydrodyne Process

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Summary and Implications

In this research, exposure of pork to an explosive charge within a water-filled container created an immediate improvement in tenderness and enhanced proteolysis upon subsequent storage. Hydrodyne-treated pork was as tender 1 day post mortem as untreated pork aged 40 days. The tenderness advantage of the Hydrodyne process to unaged pork is immediate and appears unrelated to proteolysis. The Hydrodyne process is a very effective tenderization technique providing benefits similar to aging.

Introduction

Pork tenderness, the main factor in meat palatability and overall consumer satisfaction, is inconsistent. The traditional methods to enhance tenderness — aging, mechanical tenderization and supplemental enzymes — require additional holding periods, space and/or labor. A technology offering immediate improvement in tenderness with minimal cost has many advantages.

The Hydrodyne process (patent numbers 5,273,766 and 5,328,403) uses a small explosive charge to generate a shock wave in water (liquid medium). United States Department of Agriculture scientists have shown (and we have confirmed) that the shock wave passes through the muscle, causing small tears which disrupt the structure and immediately enhance tenderness. Little is known about the effect of the Hydrodyne process on proteolysis and aging in pork. The objective of this study was to determine the extent to which Hydrodyne treatment alters pork tenderness and muscle proteolysis during aging.

Materials and Methods

Scientists from the USDA-Agricultural Research Service, Meat Science Research Laboratory in Beltsville, MD have worked with Hydrodyne, Inc. (San Juan, PR) to develop the technology. In this experiment, the meat was packaged twice, first in a vacuum package then in a rubber bag. The meat was supported against a steel plate (0.78 in thick) on the floor of a plastic container (55 gal capacity) so the ensuing shock wave reflected back through the meat. The explosive was composed of a liquid (nitromethane) and a solid (ammonium nitrate), neither of which are explosive until combined. The Hydrodyne process generated about 10,000 psi of force.

Two studies were conducted. Study 1 involved 24 control and 24 Hydrodyne pork loins treated one day post mortem. Study 2 consisted of paired loin pieces treated one day post mortem (12 controls and 12 Hydrodyne) then aged for 40 days. Shear force values were determined on chops (.5 in thick) cooked to an internal temperature of 162°F. After cooling, 0.5 in diameter cores (8-10 cores) were removed and sheared using a Warner-Bratzler shear blade mounted on a Food Texture Corporation Texture Measurement System.

Myofibrils to be used for electrophoresis were isolated from raw muscle samples by differential gradient centrifugation. Electrophoresis was performed to identify protein fragments with different molecular weights. Greater proteolysis results in smaller protein fragments, which settle as bands in the lower part of the electrophoretic gels.

Data were analyzed using analysis of variance and F-tests to determine the significance of differences.

Table 1. Shear force and cook loss of study 1 (unaged) pork loin pieces

	Control	Hydrodyne
Shear force, lb	12.41[a]	8.29[b]
Cook loss, %	28.81[a]	26.46[b]

[a,b]Means within a row lacking a common superscript letter differ (P < .05).

Results and Discussion

Shear force of unaged, Hydrodyne-treated pork was significantly (P<.01)

Table 2. Shear force and cook loss of study 2 (aged) pork loin pieces

	Day 1		Day 40	
	Control	Hydrodyne	Control	Hydrodyne
Shear force, lb	9.35[a]	7.74[b]	8.36[b]	8.00[b]
Cook loss, %	29.88[a]	29.64[a]	29.98[a]	28.06[a]

[a,b]Means within a row lacking a common superscript letter differ (P < .05).

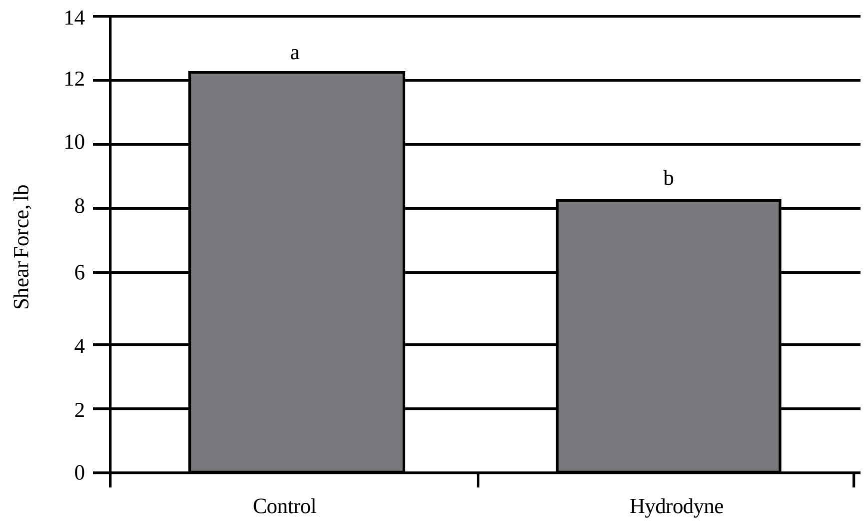

Figure 1. Shear force of pork loin pieces in study 1 (unaged, 1 day post mortem).

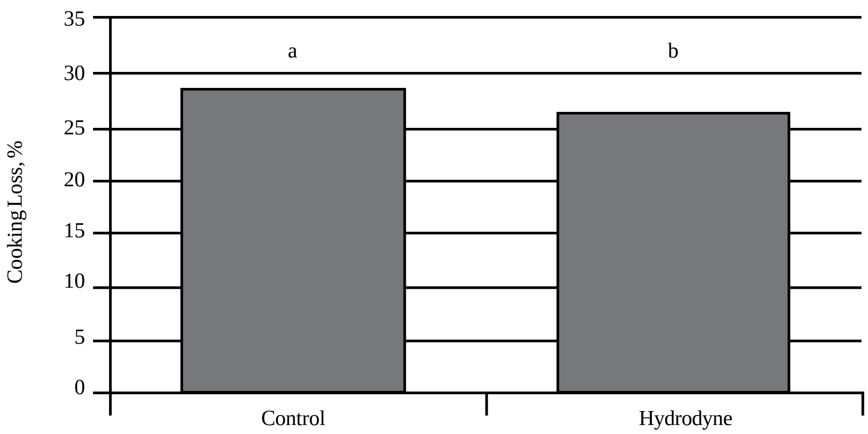

Figure 2. Cooking loss of pork loin pieces in study 1 (unaged, 1 day post mortem).

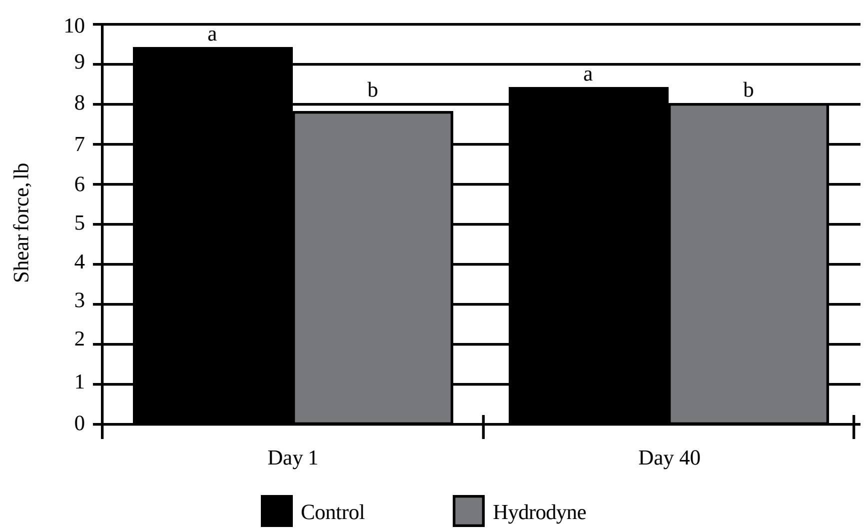

Figure 3. Shear force of pork loin pieces in study 2 (aged, 40 days post mortem).

lower (33%) than the controls (8.29 versus 12.41 pounds) in study 1 (Table 1) after one day post mortem (Figure 1). Hydrodyne-treated chops exhibited a 2.4 percent lower cooking loss (P<.05) than control chops (Figure 2).

In study 2 (Figure 3), Hydrodyne-treated pork was significantly (P < .05) more tender (17 percent lower shear force) than control pork (Table 2) one day post mortem (7.74 versus 9.35 pounds), but not at 40 days post mortem (8.00 versus 8.36 pounds). Aging improved tenderness in the control samples (P<.01) but not in Hydrodyne-treated samples (P>.05). There were no differences in cooking loss among treatments in study 2 (Figure 4). The Hydrodyne process immediately improved pork tenderness one day post mortem and aging of control and Hydrodyne-treated pork 40 days reduced the differences.

Electrophoretic gels with gradations of porosity were prepared to further evaluate proteolysis. For unaged samples (study 1), patterns on electrophoretic gels indicated a subtle, but inconsistent, benefit of Hydrodyne treatment on proteolysis (Figure 5). Smaller protein fragments, an indication of extended proteolysis, were often more frequent and in greater amount in Hydrodyne-treated pork than controls. This was not always the case one day post mortem, however, and it is difficult to draw strong conclusions from the data.

In study 2, Hydrodyne-treated samples aged 40 days clearly showed more extensive proteolysis than untreated samples (Figure 5). The location of the bands on the gels indicated degradation of higher molecular weight proteins and the presence of additional bands showed that proteolysis had occurred to a greater extent in Hydrodyne-treated pork than in the controls.

Given that Hydrodyne treatment generated greater proteolytic degradation of proteins, it was surprising that tenderness after extended aging was not different. It appears the connective

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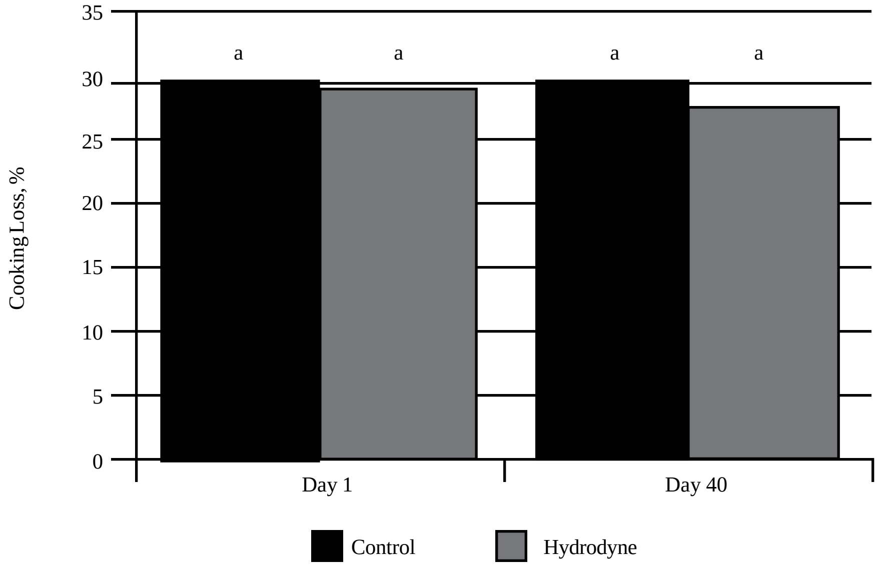

Figure 4. Cooking loss of pork loin pieces in study 2 (aged, 40 days post mortem).

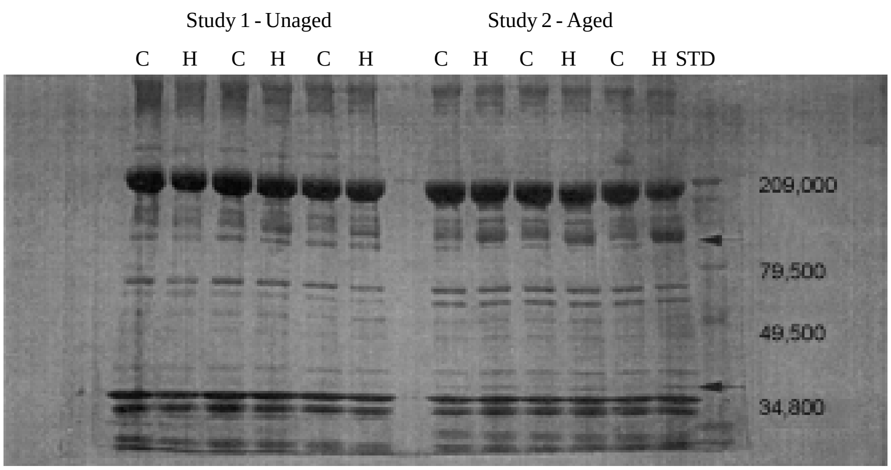

Figure 5. Electrophoretic gel of proteins from unaged (study 1) and aged (study 2) pork loin pieces.

tissue structure of muscle, which undergoes very few changes during post mortem storage, may create a limit to which proteolysis can enhance tenderness, providing a threshold tenderness level. As a result, pork aged 40 days undergoes sufficient proteolysis to become similar in tenderness to Hydrodyne-treated pork. It is also interesting to note that Hydrodyne-treated pork one day post mortem, was as tender as untreated pork aged 40 days.

Conclusions

Enhanced proteolysis does not appear to be a major mechanism of tenderization in Hydrodyne-treated pork. These data indicate tenderness of Hydrodyne-treated pork (1 day post mortem) is equivalent to pork aged 40 days. The Hydrodyne process provides an immediate tenderness advantage to unaged pork.

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