EFFECTS OF ELECTRICAL STIMULATION AND HOT BONING ON SENSORY AND PHYSICAL CHARACTERISTICS OF PRERIGOR COOKED BEEF ROASTS.

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INTRODUCTION

ENERGY conservation is of vital importance to the meat industry which is one of the major consumers of energy among food industries. For meat products that require only minimal or no reheating, prerigor cooking of hot boned muscle would appear to be a feasible method to lower unit energy cost. Marsh (1977) cited improved tenderness and reduced cooking losses as advantages to prerigor cooking with alterations in shape during cooking as a possible disadvantage. Ramsbottom and Strandine (1949), Paul et al. (1952), Weidemann et al. (1967) and Cia and Marsh (1976) have found prerigor cooked muscle to be more tender than postrigor cooked muscle. However, Ray et al. (1980) and Montgomery et al. (1977) reported decreased tenderness in prerigor cooked muscle.

Sensory and physical characteristics of hot boned, prerigor cooked beef muscle (especially thin-sliced products) have not been extensively documented. Thus, in this study we evaluated those characteristics on pre- and postrigor semimembranosus and semitendinosus muscles cooked by three methods.

EXPERIMENTAL

Electrical stimulation, muscle boning and cooking procedures

THIRTY short-scrotum cattle with an average live slaughter weight of 490 kg were used. Both sides of all carcasses were subjected to electrical stimulation within 1 hr post-stunning. The electrical stimulation procedure consisted of 100 impulses of 1 sec duration using 100 V and less than 5 amps. The semimembranosus and semitendinosus muscles from one side of 30 short-scrotum bull carcasses were removed within 1.5 hr post-exsanguination, while the same muscles were removed from the opposite sides after 7 days of cooler storage (2°C).

Before being cooked, muscles were rubbed with a commercial roast beef preparation, placed into PVDC bags, vacuumized and cooked to an internal temperature of 68°C using one of three cooking systems. These systems were steam, hot water vat or convectional electric oven. Following cooking, when the roasts had cooled to 25°C, 475-525 g sections were removed from the interior of each muscle, vacuum packaged and frozen at -28°C. Sections were held at -28°C for 45-60 days and then evaluated for sensory and physcial characteristics. A second study utilized 24 steers and 20 short-scrotum bull carcasses. Only one side of these carcasses was subjected to electrical stimulation using the process previously described. These cattle were derived from seven breed combinations involving the Charolais, Hereford, and Brangus breeds of cattle. The remaining procedures were common to both studies.

Sensory panel and physical evaluations

Roast sections were thawed at 3°C for 36 hr before they were served to the panelists. Thaw loss percentages were determined from pre- and post-thawing weights. Degree of doneness was scored by two evaluators using an 8-point photographic scale (8 = very rare, 1 = very well done). Samples were approximately 7°C at the time of serving. Meat cubes (1.2 cm) were served to panelists. A 10-member descriptive attribute panel trained according to procedures outlined by AMSA (1978) was used to evaluate samples. Panelists assigned scores according to the following attributes and scales: tenderness, 8 = extremely tender, 1 = extremely tough; juiciness, 8 = extremely juicy, 1 = extremely dry; connective tissue amount, 8 = none, 1 = abundant; and roast beef and seasoning intensity, 8 = extremely intense, 1 = extremely bland. Six samples were evaluated at each session: paired hot- and cold-boned samples from each of the three cooking methods.

Since differences in tenderness were detected between hot- and cold-boned roasts served as cubes, the sensory panel also evaluated thinly sliced (2 mm) semitendinosus muscle. The strips of sliced muscle were rolled to a dimension of 1.2 x 1.2 x 3.8 cm and held together with toothpicks. The samples were served au jus; just before serving, they were dipped for 3 sec in a hot (77°C) solution prepared from a dry mix (The R. T. French Co.). The dry ingredients were mixed with water on a 1 g to 30 ml ratio that was heated to boiling.

Samples were sheared with the Instron and Warner-Bratzler shear machines according to procedures outlined in the AMSA (1978) guidelines. All cores were 1.27 cm in diameter. Each core was sheared twice with eight cores per roast subjected to Instron maximum single blade shear force and two cores used for Warner-Bratzler shear force.

Statistical analyses

Data were analyzed according to analysis of variance procedures (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

SENSORY and physical characteristics for hot- and cold-boned semimembranosus and semitendinosus roasts are given in Table 1. Comparisons are made only between hot- and cold-boned roasts within a muscle or sample form (cubes and thin slices) presented to panelists. For both muscles served as cubes, cold-boned or postrigor cooked roasts were rated as being more tender, lower in the amount of connective tissue and less juicy than hot boned or prerigor cooked roasts. Shear force values obtained from both the Universal Instron and Warner-Bratzler shear machines support the tenderness differences found by the sensory panel between hot- and cold-boned roasts. Shear force values obtained after cooking and before freezing on adjacent muscle samples to those used in this study also reflected greater tenderness for cold-boned than for hot-boned roasts (Ray et al., 1980). Also, decreased tenderness of prerigor cooked pork loin chops and roasts has been reported by Montgomery et al., 1977). However, several studies have shown that prerigor cooked muscle is more tender than muscle cooked after the completion of rigor (Ramsbottom and Strandine, 1949; Paul et al., 1952; Weidemann et al., 1967). Cia and Marsh (1976) found that beef sternomandibularis muscle was quite tender when cooked prerigor by either water or microwave techniques. They suggested that the improved tenderness of prerigor cooked muscle was the result of supercontraction which produced fiber shattering; whereas when increased toughness has been found in prerigor cooked muscle, (Montgomery, et al., 1977), results have been attributed to heat-stimulated contraction of heat rigor without fiber shattering. It is possible that in our study, the slower cooking methods employed produced extensive heat rigor rather than supercontraction. Panelists commented that many of the particles of completely masticated hot-boned cooked product were "hard" and "gritty" in texture. Panelists probably associated this "grittiness" with more connective tissue in hot boned samples, when in fact it was probably extensive areas of supercontraction nodes produced under heat rigor. The shear force values for pre- and postrigor roasts in our study are very similar to those found on adjacent roasts after cooking and before freezing (Ray et al., 1980). Thus, the freezing and thawing of these roasts exerted no effect on shear force values.

Although, sensory panelists detected reduced tenderness in hot-boned prerigor cooked semitendinosus roasts served as cubes compared to cold-boned semitendinosus samples, no palatability differences were found between cold- and hot-boned roasts when samples were served as slices. Thus, it would appear that, regardless of the cooking method, the palatability of prerigor cooked beef probably is quite acceptable when it is served thinly sliced. Because we were unable to obtain consistent and uniform samples for shearing, no Instron or Warner-Bratzler shear force values are given for sliced product. Although differences between muscles and sample forms were not statistially analyzed, semitendinosus muscle served as slices were more juicy and had more intense roast beef and seasoning flavor than when the same muscle was served as cubes. This difference was probably due to our serving the slices au jus.

The cooking methods used on the roasts exerted no influence ($P>0.01$) on any of the sensory and physical measurements. Likewise, no interaction effects were detected between boning temperature and method of cooking. Even though the hot water vat cooking system required less time per unit weight to reach an internal roast temperature of 68°C than the other systems, this method did not affect palatability.

In the second study, the major difference was again the higher tenderness scores and lower Warner-Bratzler and Instron shear force values for roasts cooked from cold-boned, postrigor muscle compared to roasts cooked from hot-boned, prerigor muscle. Electrical stimulation had no effect on sensory or physical traits, except that the tenderness differences between cold and hot-boned beef were less from sides that were electrically stimulated compared to sides receiving no electrical stimulation. The influence of sex (steer vs short-scrotum bulls) and breed on sensory and physical characteristics was also minimal.

The cooking of hot-boned, prerigor semitendinosus and semimembranosus muscles by cooking methods similar to those of our study may result in tenderness reductions. However, when this non-reheated product is used in a thinly sliced or similar form, any tenderness problems should be eliminated. Cooking of hot-boned prerigor muscle can result in significant energy savings, especially if the product does not require reheating.

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Table 1. Sensory and physical characteristics of beef roasts as influenced by muscle, sample form at evaluation and postmortem boning temperature.

Characteristic	Cube				Thin slice	
	Semimembranosus		Semitendinosus		Semitendinosus	
	Cold Boned	Hot Boned	Cold Boned	Hot Boned	Cold Boned	Hot Boned
Tenderness[a]	6.4[b]	5.3[b]	6.6[b]	5.2[c]	7.7	7.7
Connective tissue amount[a]	7.1[b]	6.2[c]	7.4[b]	6.5[c]	7.9	7.8
Juiciness[a]	5.2[b]	5.7[c]	4.8[b]	5.4[c]	6.5	6.6
Roast beef flavor intensity[a]	4.7	4.6	4.1	4.0	5.3	5.3
Seasoning flavor intensity[a]	3.1	3.4	2.6	2.7	4.4	4.6
Thaw loss, %	8.3	7.2	9.6	9.6	12.4[b]	10.5[c]
Degree of doneness score[a]	3.0	2.9	2.7	2.7	2.7	2.9
Instron maximum single blade shear force (kg)	6.5[b]	9.8[c]	6.1[b]	9.2[c]	-	-
Warner-Bratzler shear force (kg)	4.3[b]	7.3[c]	3.9[b]	6.5[c]	-	-

[a]Scoring systems based on 8 = extremely tender, juicy and intense in roast beef and seasoning intensity; none in connective tissue amount and very rare in degree of doneness. 1 = extremely tough, dry and bland in roast beef and seasoning intensity, abundant in connective tissue amount and well done in degree of doneness.

[bc]Means on the same line under a muscle and sample configuration category possessing different superscripts are significantly different (P<0.01).