ENDPOINT TEMPERATURE, COOKING METHOD, AND MARBLING DEGREE HAVE DIFFERENT EFFECTS ON WARNER-BRATZLER SHEAR FORCE OF BEEF STRIP LOIN, BOTTOM ROUND, AND BRISKET MUSCLES

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Summary

Our objective was to determine the effects of endpoint temperature, cooking method, and marbling on Warner-Bratzler shear force (WBSF; an objective method for determining tenderness) of three beef muscles. Eighteen subprimals of a muscle containing low content of connective tissue, *longissimus lumborum* (strip loin), and two muscles containing a high content of connective tissue, *biceps femoris* (bottom round) and *deep pectoralis* (brisket), were selected from USDA Select and Choice (Certified Angus Beef) carcasses. After 14 days of aging, subprimals were frozen, fabricated into steaks, and stored frozen until cooking. Steaks were assigned to one of two cooking methods, the Magikitch'n® electric belt grill (a rapid conduction method) or a water bath (a slower, convection method); and one of nine endpoint cooking temperatures, 104, 113, 122, 131, 140, 149, 158, 167, or 176°F. According to WBSF results, optimum tenderness for the strip loin occurred around 131°F. Higher marbling protected tenderness at higher endpoint temperatures. Tenderness increased in bottom round and brisket muscles as endpoint temperature increased from 104 to 140°F, then tenderness decreased as endpoint temperature rose from 149 to 176°F. Endpoint temperature was the only significant factor affecting bottom round tenderness. Steaks cooked in the water bath had higher WBSF and, therefore, were less tender than those cooked on the belt grill. This was true for both the strip loin and brisket. The effect of increasing endpoint temperature on WBSF of the strip loin was different than for the bottom round and brisket.

Introduction

Tenderness is the most important beef palatability attribute, and the effects of cooking temperature and method on tenderness are important to both meat researchers and consumers. It is generally known that meat toughens when it is cooked to higher endpoint temperatures, but interactions with cooking method and marbling score can have an effect on the rate of toughening. Because of different amounts of connective tissue, different muscles are affected by endpoint temperature, cooking method, and marbling differently. Therefore, our objective was to evaluate the effects of endpoint temperature, cooking method, and marbling on Warner-Bratzler shear force (WBSF; an objective measure of tenderness) of three beef muscles. The muscles studied were the *longissimus lumborum* (strip loin), a muscle containing a low content of connective tissue, and the *biceps femoris* (bottom round roast) and *deep pectoralis* (brisket), muscles that contain a high content of connective tissue.

Experimental Procedures

Eighteen subprimals (boneless strip loin, bottom round, and brisket) from USDA Select (low marbling score) and Choice (high marbling score; Certified Angus Beef) carcasses were purchased and divided into the respective muscles. Muscles were vacuum packaged

and held at 34°F for 14 days and then frozen (-35°F). Each frozen muscle was sawed into 1-inch-thick steaks, vacuum packaged, and stored frozen until cooking. Steaks were thawed at 39°F before cooking. Steaks were randomized into one of two cooking treatments, a Magikitch'n® electric belt grill at 199°F (rapid, conduction cooking) or a water bath at 199°F (slower, convection cooking), and one of nine endpoint temperatures: 104, 113, 122, 131, 140, 149, 158, 167, or 176°F. The center temperatures of steaks were monitored by using copper-constantan thermocouples. Cooked steaks were then refrigerated overnight at 34°F. Six cores were removed parallel to the muscle fiber direction from each steak, and WBSF was measured by using an Instron® Universal testing machine.

Results

Strip Loin. Figure 1 shows the effects of endpoint temperature and quality grade on WBSF of strip loin steaks for the two cooking methods. Strip loin steaks cooked by the slower, convection, water-bath method had greater WBSF ($P<0.0001$) values (tougher) than those cooked on the more rapid, conduction, belt-grill method. The combination of low marbling score (USDA Select) and cooking to higher endpoint temperatures resulted in higher ($P<0.05$) WBSF (tougher steaks) than high marbling score and cooking to lower endpoint temperatures.

Bottom Round. Two distinct phases of tenderization/toughening occurred for bottom round steaks as endpoint cooking temperature increased. Between 104 and 140°F, WBSF decreased, whereas between 140 and 158°F, WBSF increased (Figure 3). There were no differences ($P>0.05$) in WBSF among bottom round steaks that were due to quality grade or cooking method.

Brisket. Values of WBSF for brisket steaks decreased (became more tender) as endpoint temperature increased from 113 to 149°F (Figure 4). This was followed by an increasing WBSF trend between 149 and 176°F. As with the strip loin steaks, water-bath cookery resulted in greater ($P=0.0001$) WBSF than belt-grill cookery. Quality grade did not have a significant effect on WBSF of brisket steaks.

Discussion

Endpoint temperature and cooking method were more important factors than quality grade for WBSF of the three muscles studied, and quality grade was significant only in the strip loin. Other researchers have reported a distinct toughening trend between 104 and 122°F, but we did not observe this trend. We did, however, observe an increasing trend for WBSF for all three muscles between 149 and 176°F, but this increase was not as steep as that reported in previous research.

Our results suggest that optimum tenderness (lowest WBSF) for the strip loin occurs around 131°F (very rare), and optimum tenderness for the bottom round and brisket occur at 140 and 149°F, respectively. USDA Choice strip loin steaks were less affected by increasing endpoint temperatures than their Select counterparts, suggesting a protection of tenderness with the greater amounts of marbling in this low connective tissue muscle. More rapid cookery on the belt grill resulted in lower WBSF (more tender) than the slower, convection, water-bath cooking for strip loin and brisket steaks. The effects of increasing endpoint temperature on WBSF of muscle containing a low content of connective tissue (strip loin) were different from those of muscles containing greater amounts of connective tissue (bottom round and brisket). Endpoint temperature and cooking method had a greater effect on WBSF than did quality grade, especially in muscles with a high content of connective tissue.

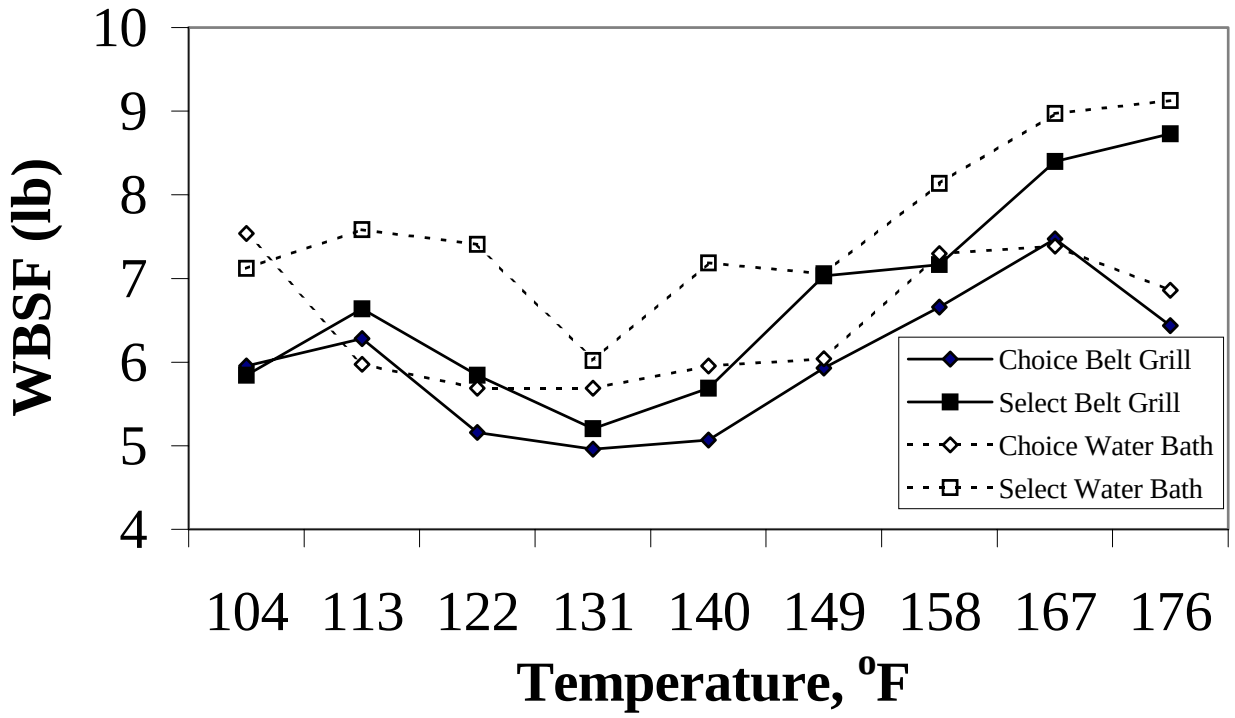

Figure 1. Effects of Endpoint Temperature and Quality Grade on Warner-Bratzler Shear Force (WBSF) of Strip Loin Steaks Cooked on the Belt Grill or in the Water Bath.

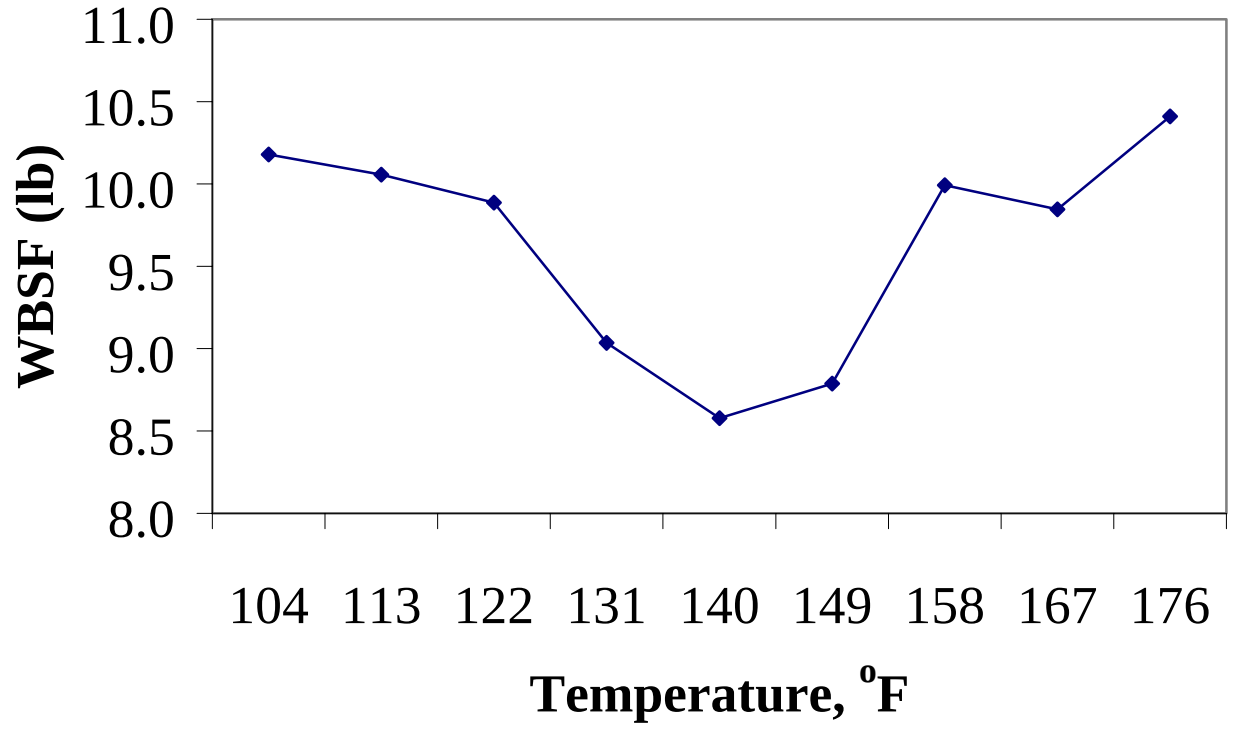

Figure 2. Effects of Endpoint Temperature on Warner-Bratzler Shear Force (WBSF) of Bottom Round Steaks.

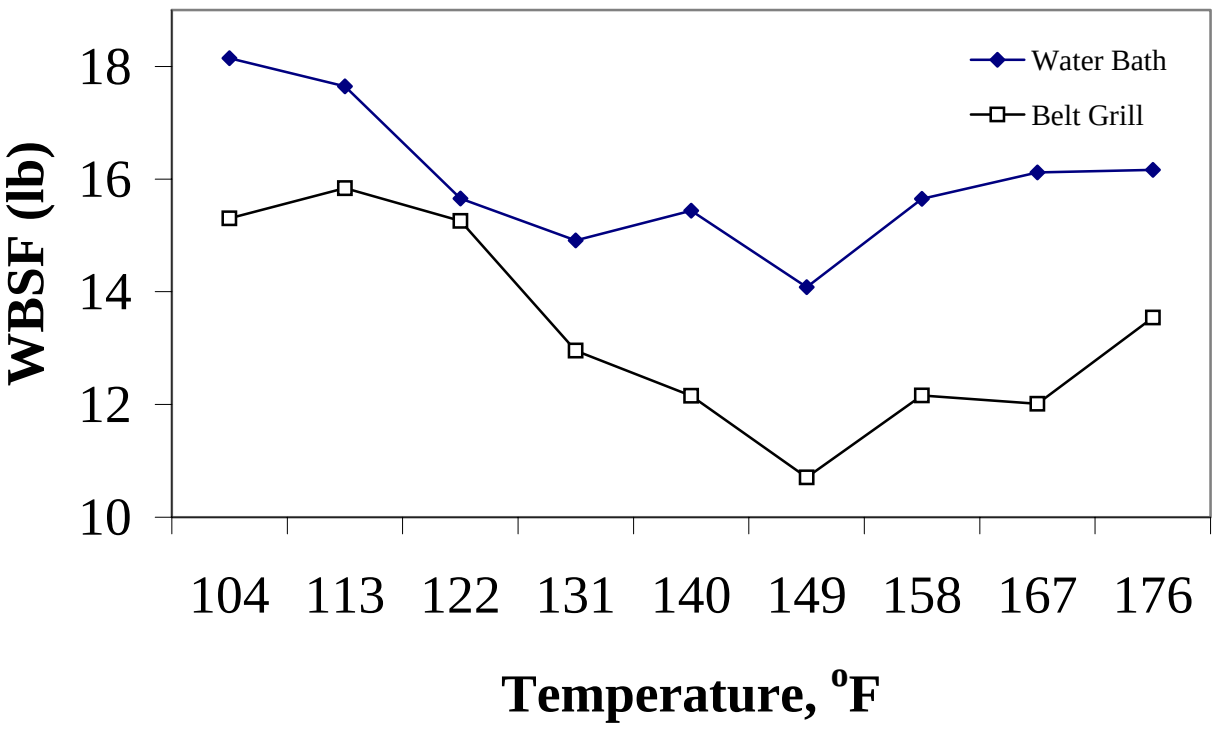

Figure 3. Effects of Endpoint Temperature on Warner-Bratzler Shear Force (WBSF) of Brisket Steaks Cooked in the Water Bath or on the Belt Grill.