# Comparison of Warner-Bratzler Shear Force Values of Beef *Longissimus* Steaks Cooked on a Magikitch'n Belt Grill vs. a Hobart Char Broiler

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## SUMMARY

Two different steak cooking methods were evaluated to ascertain their effect on subsequent Warner-Bratzler shear (WBS) force values. Forty-seven pairs of strip loin steaks, cooked to a target end temperature of 158 or 176ºF, were utilized such that one steak from each pair was cooked on a Hobart char broiler, while the other steak from each pair was cooked on a Magikitch'n belt grill. Belt grilled steaks cooked to 176ºF tended to have higher (P = 0.25) WBS values (13.5 vs 12.4 lb) and required shorter (P < 0.001) cook times (395 vs 1241 sec) than Hobart char broiled matched pair steaks. Belt grilled steaks cooked to 158ºF had equal WBS force values and required longer (P < 0.001) cook times (395 vs 981 sec) than the corresponding matched pair steaks cooked on a Hobart char broiler. Belt grilling is a more rapid, consistent method of cooking steaks for measuring tenderness characteristics of beef steaks.


**Key Words:** Tenderness, Beef, Cooking, Shear force

## INTRODUCTION

Use of an appropriate cooking method is essential in experiments involving measurement of meat tenderness. The method used to cook beef steaks should be consistent and repeatable, and should reflect consumer preparation of the product at home. Many methods have been employed in tenderness research including water boiling of samples in a plastic bag (Chrystall et al., 1994), deep-fat frying (Carpenter et al., 1968), open-hearth broiling and belt grilling (Wheeler et al., 1998).

Many factors present potential errors in the evaluation of meat tenderness. Wheeler et al. (1998) suggested that the greatest source of error variance was the cooking phase. Errors, coupled with differences in steak preparation protocol, make direct comparison of Warner-Bratzler shear (WBS) force values among different cooking methods difficult.

Historically, electric or gas broiling of steaks has been a popular method of cooking for purposes of determining tenderness of beef. However, the consistency of cooking achieved by this method has been questioned. A recent study indicated that the use of a belt grill is a quicker, more precise method of cooking steaks for tenderness studies (Wheeler et al., 1998). Thus, the objective of this experiment was to evaluate differences in WBS values of beef *longissimus* steaks cooked on a Hobart char broiler vs. a Magikitch'n belt grill.

## MATERIALS AND METHODS

***Sampling***. Forty-seven strip loins (IMPS #180) from carcasses randomly selected from a commercial beef slaughter facility were collected and randomly aged for 3, 7, or 14 days postmortem, and frozen. Two steaks (1.0 in thick) were cut from the posterior end of each strip loin (using a bandsaw) resulting in 47 pairs of strip steaks. The pairs were cut to reflect the 7th and 8th steaks counting from the anterior end of the strip loin towards the posterior end. Pairs were then randomly assigned to a cooked internal endpoint temperature of either 158 or 176ºF. Assignment resulted in 28 pairs that were cooked to 158ºF and 19 pairs that were cooked to 176ºF.

***Cooking***. Frozen steaks were tempered for 24 hours at approximately 40ºF and one steak from each pair was randomly assigned to one of two methods of cookery. The first method used was belt grilling using a Magikitch'n belt grill (Magigrill model TBG-60; Magikitch'n Inc., Quakertown, PA). The second method used was our open-hearth broiler (Hobart model CB-51 char broiler; Hobart Corporation, Troy, OH). Pre- and post-cooking temperatures were monitored using a handheld thermometer (Omega model HH21 thermometer; Omega Engineering, Inc., Stamford, CT). In addition, cook time was measured and recorded for each steak.

***Warner-Bratzler Shear Force.*** Cooked steaks were cooled to room temperature. Eight cores ( 0.5 in diameter) were then removed using a mechanical coring device from eight standardized core locations (figure 1) on each steak. Removal was accomplished parallel to the orientation of the muscle fibers. Each core was sheared once with a Warner-Bratzler shear force instrument.

***Statistical Analysis.*** Descriptive statistics and two-sample paired t-tests of means were performed (SAS 1999). Pearson's correlation coefficients were calculated to determine the repeatability of WBS measurement for matching cores removed within paired steaks and the average of the eight cores within each steak (SAS 1999).

## RESULTS AND DISCUSSION

Mean Warner-Bratzler shear force tended to be greater (P = 0.25) for steaks cooked on the belt grill to 176ºF than for steaks cooked on the char broiler; but did not differ significantly (Table 1). However, when cooked to 158ºF, both methods of cooking produced equal mean shear force values (Table 1). Conversely, Wheeler et al. (1998) showed that steaks cooked on a belt grill to 158ºF had larger (P < 0.01) shear force values than when cooked on an open-hearth electric broiler. Despite differences in mean WBS values, the standard deviation (SD) and range were similar for steaks cooked using the two methods (Table 1).

Steaks cooked on the belt grill were cooked according to a pre-set time rather than an endpoint internal temperature. Preliminary experiments indicated that a cook time of 395 and 470 sec was required to achieve a cooked endpoint internal steak temperature of 158 and 176ºF, respectively. In contrast, steaks cooked on the Hobart char broiler were regulated according to temperature; hence, cooking time was more variable from steak to steak. Endpoint temperature was similar between steaks cooked using the two different methods at 158ºF (Table 1). However, steaks cooked to 176ºF on the char broiler had a larger mean and SD for cooked endpoint temperature than steaks cooked on the belt grill (Table 1). This was because temperature regulation on the Hobart char broiler became increasingly difficult as the target steak

internal endpoint temperatures increased. Mean cooking time required was greater ($P < 0.001$) for steaks cooked on the Hobart char broiler at both the 158 and 176ºF internal steak endpoint temperatures (Table 1).

The Pearson correlation coefficient for the mean WBS value between the two cooking methods was greater for steaks cooked to 158ºF than for those cooked to 176ºF (0.79 vs 0.69). In addition, the eight correlation coefficients of standardized core WBS values and the correlation for all standardized core WBS values for the two cooking methods were greater for steaks cooked to 158ºF than for those cooked to 176ºF (Table2). Relatively lower correlations (0.22 and 0.37) observed at the sixth core location were possibly due to greater amounts of connective tissue being present at that site as compared to the other seven core locations (Table 2). Correlations indicated that there was more variation between belt grilled and char broiled steak WBS values when steaks were cooked to 176ºF than when steaks were cooked to 158ºF.

## IMPLICATIONS

WBS values for steaks cooked to an internal endpoint temperature of 158 or 176ºF using the Hobart char broiler vs. the belt grill were moderately correlated ($r = 0.69$ and 0.79 respectively), particularly when steaks were cooked to 176ºF. Hence, a direct comparison of shear force values from steaks cooked using the two methods is subject to some variability due to cooking method.

Although neither cooking method produced significantly larger or more variable WBS values, cooking traits of steaks were more difficult to control on the Hobart char broiler. Cook time of strip steaks was significantly longer and more variable on the Hobart char broiler (open-hearth) than on the belt grill. Similarly, Hobart broiled steak temperature was more variable as target endpoint internal cooked temperatures increased. Belt grilling of strip loin steaks is a more rapid, consistent method of beef cookery than open-hearth broiling in research studies that are designed to objectively measure beef tenderness.

## LITERATURE CITED


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**Figure 1. Strip loin steak cores removed from eight standardized core locations**

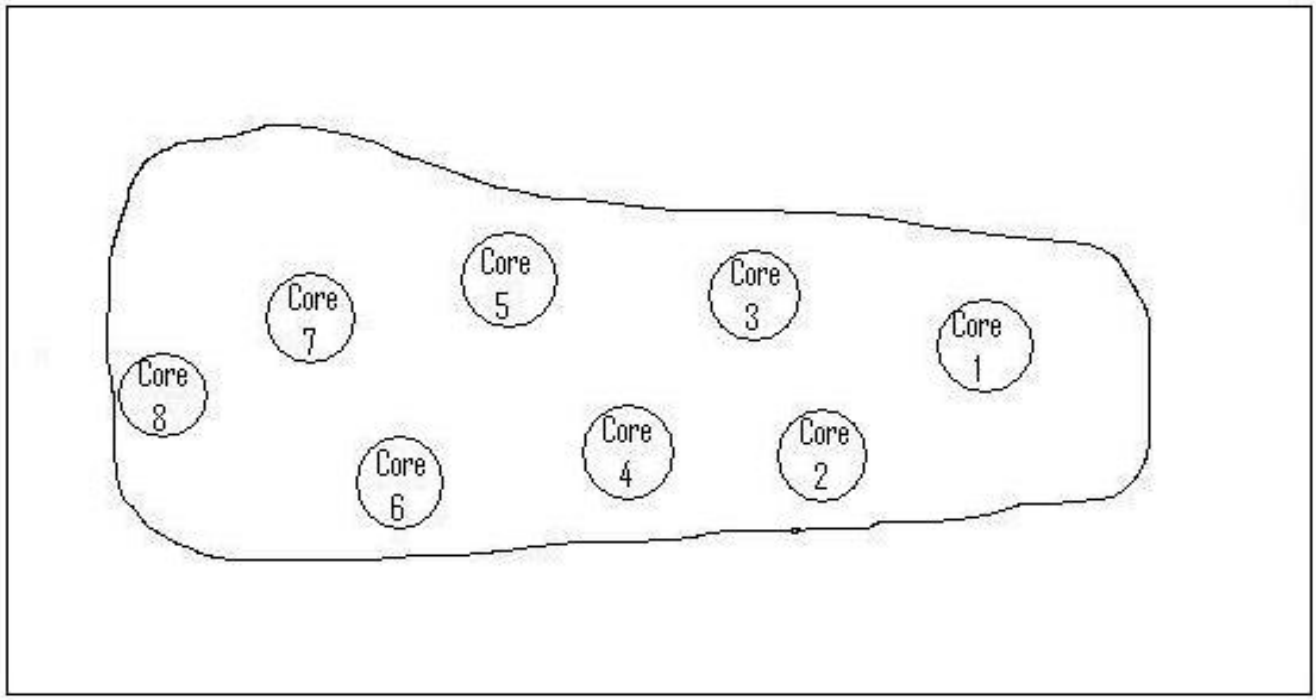


**Table 1. Descriptive statistics for WBS[a], end cook temperature, and cook time of strip loin steaks cooked to 158 and 176ºF on a Magikitch'n belt grill or on a Hobart char broiler.**

| | Magikitch'n belt grill | | | | | Hobart char broiler | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Trait | n | Mean | SD | Min. | Max. | n | Mean | SD | Min. | Max. | P > T |
| 158ºF WBS, lb | 28 | 11.5 | 3.3 | 6.8 | 20.9 | 28 | 11.5 | 3.3 | 7.7 | 23.6 | 0.95 |
| 176ºF WBS, lb | 19 | 13.5 | 3.1 | 7.7 | 20.1 | 19 | 12.4 | 2.4 | 7.7 | 16.5 | 0.25 |
| 158ºF End cook temperature, ºF | 28 | 160.0 | 3.4 | 152.2 | 165.1 | 19 | 161.1 | 2.1 | 159.0 | 165.0 | 0.16 |
| 176ºF End cook temperature, ºF | 19 | 172.6 | 1.4 | 169.2 | 174.5 | 19 | 176.2 | 2.6 | 174.0 | 184.5 | < 0.0001 |
| 158ºF Cook time, seconds | 28 | 395 | 0 | 395 | 395 | 19 | 981 | 118.9 | 580 | 1120 | < 0.0001 |
| 176ºF Cook time, seconds | 19 | 470 | 0 | 470 | 470 | 19 | 1241 | 104.1 | 1060 | 1410 | < 0.0001 |

[a]Warner-Bratzler shear force values, lb.

**Table 2. Pearson correlation coefficients of shear force values for the eight standardized cores (Figure 1), shear force values for cores 1-8, and the mean shear force value of the eight cores from strip loin steaks cooked to 158 and 176ºF on a Magikitch'n belt grill or on a Hobart char broiler.**

| Steak endpoint temperature | Core 1[a] | Core 2[b] | Core 3[c] | Core 4[d] | Core 5[e] | Core 6[f] | Core 7[g] | Core 8[h] | Cores 1-8[i] | Mean[j] |
|---|---|---|---|---|---|---|---|---|---|---|
| Cooked to 158ºF | 0.70 | 0.70 | 0.71 | 0.68 | 0.71 | 0.22 | 0.69 | 0.67 | 0.63 | 0.79 |
| Cooked to 176ºF | 0.35 | 0.68 | 0.46 | 0.55 | 0.16 | 0.37 | 0.54 | 0.26 | 0.46 | 0.69 |

[abcdefgh]Correlation for matched pair core Warner-Bratzler shear values at eight individual standardized locations.
[i]Correlation for matched pair core Warner-Bratzler shear values for all eight standardized core locations simultaneously.
[j]Correlation for matched pair mean Warner-Bratzler shear values for the eight cores from each steak.