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The influence of cooking rate and holding time on beef chuck and round flavor

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Abstract

Steaks from seven muscles from 10 beef carcasses were cooked quickly or slowly and held 0 or 1 h to explore the influence of cooking rate and holding time on beef flavor. Moisture, ash, pH, and heme–iron concentration were determined for each muscle. Trained sensory panels evaluated the steaks for tenderness, juiciness, connective tissue, and off-flavor intensity in addition to identifying specific off-flavors. Off-flavor intensity was lowest when beef was cooked slowly (on a 149 °C gas grill instead of a 249 °C grill) and when it was held for 1 h prior to sensory evaluation. The *M. infraspinatus* had the least intense off-flavor and the *M. vastus intermedius* had the most intense off-flavor. Slow cooking or holding for 1 h prior to consumption reduced the intensity of off-flavor in value cuts from the beef chuck and round while chemical characteristics did not contribute to off-flavor in this study.
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1. Introduction

The beef chuck and round represent around 53% of the carcass. Due to recent research, supply, and marketing campaigns, the value of the beef carcass has increased approximately $33/100 kg since 1998. As much as $13.23/100 kg is attributed to the fabrication of steaks from individual muscles from the chuck (Ishmael, 2004) that were shown to have acceptable palatability attributes in the muscle profiling study (Von Seggern, Calkins, Johnson, Brickler, & Gwartney, 2005). Numerous studies have shown several muscles from the chuck and round to be tender (Belew, Brooks, McKenna, & Savell, 2003; Elam, Brooks, Morgan, & Ray, 2002b; Johnson et al., 1988; Kukowski, Maddock, & Wulf, 2004; McKeith, De Vol, Miles, Bechtel, & Carr, 1985) and acceptable in overall palatability (Elam, Brooks, Morgan, & Ray, 2002a, 2002b; Kukowski et al., 2004; McKeith et al., 1985) by consumers and trained panelists. Therefore, the industry term value cuts refers to the beef muscles, mainly from the chuck and the round, that are being considered for utilization other than ground beef or roasts.

The foodservice industry has begun to use various steaks obtained from the chuck and the round. Managers in this industry report an increasing number of complaints about off-flavors in some of the value cuts from the beef chuck and round. Some of the typical off-flavors are described as liver-like, fatty, sour, and metallic. Research has been conducted that investigated the effect of quality grade (Yancey, 2002), aging (Calkins, 2002b; Yancey, 2002), marination (Streff, Wulf, & Maddock, 2003), degree-of-doneness (Adhikari, Keene, Heymann, & Lorenzen, 2004; Calkins, 2002a; Streff et al., 2003), and cooking methods (Adhikari et al., 2004; Miller, 2002) on the occurrence of off-flavors. Other research has investigated the different biochemical characteristics that might cause the undesirable flavor. Yancey (2002) looked at lipid oxidation factors, such as fatty acids and sarcoplasmic proteins, which might lead to liver-like flavors and found that myoglobin concentration seemed to be related to the liver-like flavor.

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Flavor is a combination of aroma and taste. As a result, some of the compounds that are part of the normal beef flavor may be concentrated or lost due to cooking. Goodson et al. (2002) discovered that flavor was the driving factor for overall acceptance ratings of clod steak (IMPS #114; NAMP, 1997) in an in-home beef study. In the foodservice industry, meat is cooked and then traditionally held for a period of time before being served. Cuts commonly used in foodservice (e.g., prime rib, ribeye, and top butt steaks) are able to withstand this preparation method. With the less expensive beef value cuts being offered as substitutes for some of the main meat entrees, the impact of holding after cooking on flavor and other palatability issues needs to be addressed to ensure that customers are having pleasant eating experiences and are willing to purchase the product again. A previous study on beef roasts investigated the role cooking rate, holding time, fat trim level, endpoint temperature and oven type on flavor attributes and microbial levels (Belk, Miller, Evans, Liu, & Acuff, 1993). Endpoint temperature and oven type played the biggest role in flavor development while cooking rate, fat trim level, endpoint temperature, and oven type influenced the perception of liver-like aromatics.

Therefore, the objective of this study was to determine the role of cooking rate and holding time on sensory characteristics of beef muscles from the chuck and round.

2. Materials and methods

2.1. Muscle preparation

Seven muscles (*M. infraspinatus*-INF, flat iron; *M. teres major*-TER, shoulder tender; *M. triceps brachii*-TRI, clod heart; *M. rectus femoris*-REC, knuckle center; *M. vastus lateralis*-VAL, knuckle side; *M. vastus medialis*-VAM, knuckle bottom; and the *M. vastus intermedius*-VAI, knuckle soft) located in the clod (IMPS #114; NAMP, 1997) and knuckle (IMPS #167; NAMP, 1997) from 10 animals (5 = choice and 5 = select) were separated and trimmed of external fat after aging 7 d post-harvest. A 100 g portion of the proximal end of each muscle was removed and minced for chemical analysis. The thick band of connective tissue running through the center of the INF was removed. The TRI, REC, and VAL were cut into 2.54 cm steaks. The top and bottom portions of the INF were cut in half to make four steaks. The TER, VAM, and VAI were cut in half. Steaks were wrapped in freezer paper and frozen (−16 °C) until sensory evaluation was conducted.

2.2. Sensory analysis

Panelists for this study were selected and trained according to the guidelines and procedures outlined by the AMSA (1995). They were recruited from an advertisement in a local paper as well as among the staff in the department. Recruits were screened for the tastes of sour, sweet, bitter, and salty. During training, panelists were presented with samples with varying degrees of tenderness, juiciness, and connective tissue in order to anchor them to the scale. Panelists were trained to identify the presence of specific off-flavors (liver-like, metallic, sour, charred, oxidized, rancid, or other) contributing to the off-flavor score for the steak.

Four steaks from one USDA choice and four steaks from one USDA select muscle type were randomly served during every taste panel session. Serving order of muscles was randomized. Steaks were thawed to approximately 13.5 °C 24 h prior to cooking for sensory evaluation. One steak from each muscle was cooked quickly (FAST) with a grill (Vulcan commercial gas grill model VCCV 36-1; Vulcan Hart Corp., Louisville, KY) temperature of 249–260 °C to an internal temperature of 63 °C and brought to 65 °C during a 1 h hold in a commercial foodservice warming oven (Precision RS-201, Metal Products, Inc., Miami, FL) kept at approximately 74 °C. A second steak from the muscle was slow cooked (SLOW) with a grill temperature of 149 °C to an internal temperature of 63 °C and held for 1 h to a final internal temperature of 65 °C. The remaining two steaks from each muscle were cooked SLOW and FAST, respectively, to an internal temperature of 65 °C and served with no holding time (0 h). Steaks to be served with no holding time were timed to finish cooking near the end of the 1 h holding period of the other two steaks. Cooking times and weight losses from cooking and holding were determined.

In order to prevent bias, panelists were seated in individual booths equipped with red fluorescent lights and partitioned to reduce possible collaboration between panelists and eliminate visual differences. Each panelist was served distilled water and unsalted, saltine crackers and given 3 min between samples to cleanse their palates. The panel evaluated the 1.25 cm × 1.25 cm × 2.54 cm pieces of the eight steaks each session for tenderness, connective tissue, juiciness, and off-flavor intensity on an 8-point hedonic scale (8 = extremely tender/no connective tissue/no off-flavor/extremely juicy; 1 = extremely tough/abundant amount/extreme off-flavor/extremely dry). The panel also identified specific off-flavors.

2.3. Chemical analysis

Muscle samples were cubed, frozen in liquid nitrogen, and pulverized with a Waring blender (Waring Products Division, New Hartford, CT). Pulverized samples were stored at −80 °C and used for moisture and ash analysis with a LECO Thermogravimetric analyzer-601 (Model 604-100-400, LECO Corp., St. Joseph, MI) with a TGA-601 Windows (version 1.2, LECO Corp., St. Joseph, MI) option.

To determine pH, 10 g of pulverized sample was homogenized at 10,800 rpm for 30 s with 90 mL of double distilled water using a Polytron blender (Brinkman Instruments, New York, NY). A calibrated (4 and 7) pH probe (Orion model 9256 BN, Orion Research, Inc., Boston, MA) was

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