

DEGREE OF DONENESS OF COOKED BEEF *LONGISSIMUS* MUSCLE ALTERS LIPID BIOACCESSIBILITY

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I. OBJECTIVES

The physical properties of the foods' network influences how it disintegrates along the gastrointestinal tract, modulating both fatty acid release and bioavailability during digestion. The objective of this study was to investigate whether physical state differs significantly enough by cooking to alter the metabolic response of lipids in food.

II. MATERIALS AND METHODS

Canadian AAA boneless beef strip loins (Institutional Meat Purchase Specifications 180) containing the *longissimus* muscle ($n=3$) were procured from a commercial processing facility and aged 6 d postmortem. Loins were cut into 2.5-cm-thick steaks with the external fat removed and randomly assigned to different degrees of doneness (raw/20°C, 50°C, 60°C, 70°C, and 80°C). The steaks were individually vacuumed sealed and frozen at -30°C. Steaks were thawed at 4°C for 12 to 24 h prior to sous vide cooking. Proximate analysis was performed on the cooked steaks, and the amount of steak digested was standardized to 2% fat in a 300 g meal. The meal was prepared by blending the steak with salivary fluids to simulate mastication. Lipid bioaccessibility was assessed utilizing the advanced TIM-1 simulated gastrointestinal tract (TNO, Zeist, The Netherlands), which is a dynamic *in vitro* system that mimics human digestion. Digestion kinetics consisting of lipid digestion rate constants and bioaccessibility were measured over a 6 h simulated digestion using the TIM-1 robotic gastrointestinal track. Ileal and jejunal filtrates and ileal efflux were collected at 30, 60, 90, 120, 180, 240, 300, and 360 min, and the concentration of free fatty acids was measured using a non-esterified fatty acid test kit. The changes in network structure of the different degrees of doneness were analyzed using rheology and microscopy. A repeated measures two-way analysis of variance with the Geisser-Greenhouse correction and Tukey's Multiple Comparison Test was used to compare the effects of digestion time and degree of doneness on percentage free fatty acid bioaccessibility. GraphPad Prism 8 (GraphPad Software, San Diego, CA) was used, and statistical significance was defined as $P < 0.05$. Digestion rate was determined from linear regression, and a statistical significance was defined as no overlap of the 95% confidence intervals.

III. RESULTS

The total cumulative free fatty acid bioaccessibility (percentage) showed significant differences ($P < 0.05$) depending on the degree of doneness, with the beef cooked to 60°C giving the maximum bioaccessibility. Free fatty acid digestion rate was significantly different ($P < 0.05$) between all degrees of doneness except between 70°C and 80°C, which showed no statistical difference ($P > 0.05$). Rheology analysis showed significant ($P < 0.05$) increases in storage and loss modulus with increasing degree of doneness; furthermore, the storage modulus dominates the loss modulus for all samples. Observations of particle size from microscopy images showed a continuous decrease in particle area in the stomach after 60 min for both 20°C and 80°C samples.

IV. CONCLUSION

This research shows that the protein structural changes that occur during heating may impact the release of lipids during digestion. A better understanding of the mechanisms of digestion with relation to changes in food structure and matrices due to processing/preparation can serve in the development of foods that tailor the amount of free fatty acid release.

Keywords: beef, degree of doneness, lipid digestibility, sous vide