EFFECT OF TEMPERATURE AND PH ON THE PROTEIN DENATURATION IN MUSCLES OF DIFFERENT FIBER TYPES ANALYSED BY FOURIER TRANSFORM INFRARED (FTIR) MICRO SPECTROSCOPY

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I. OBJECTIVES

The study objective was to determine the effect of cooking temperature and pH on the protein denaturation in muscle fibers and connective tissue from muscles of different fiber types.

II. MATERIALS AND METHODS

Masseter (type I fiber) and *cutaneous trunci* (type II fiber) muscles were obtained from 1 bovine Angus cattle, 1 d postmortem. Muscles from 1 carcass were used in order to focus on the effect of the treatments and avoid the effect of animal variability, as commonly done in Fourier Transform Infrared studies in meat. Cryo-sections with 6-µm thickness were incubated at 4 temperature levels (25°C, 55°C, 60°C, and 65°C) and 2 pH levels (5.6 and 6.5). The temperatures were selected based on the sensitivity of myosin and collagen denaturation to differences in pH and temperature, and the selected pH levels corresponded to the measured ultimate pH of the muscles. Spectra (4,000–650 cm^{-1}) were collected with a Nicolet™ Continuµm™ Infrared Microscope (Thermo Fischer Scientific, Waltham, MA) from muscle fibers ($N = 5$ for each treatment) and connective tissue areas ($N = 5$ for each treatment). The data were analyzed with Unscrambler X 10.3 (Camo Analytics, Oslo, Norway) using Extended Multiplicative Scatter Correction and Savitzky-Golay smoothing. The absorbance for relevant wavenumbers in the Amide I region was analyzed using unbalanced analysis of variance in Genstat (VSN International, Hemel Hempstead, UK).

III. RESULTS

The increase in temperature resulted in a decrease in α-helices (1,655 cm^{-1} in fibers and 1,658 cm^{-1} in connective tissue) and an increase in aggregated β-sheet structures (1,624 cm^{-1} in fibers and 1,628 cm^{-1} in connective tissue). The difference in the thermal denaturation of the proteins in the muscle fibers, between the 2 muscle types at 55°C, was greater than the difference between pH, with *cutaneous trunci* showing a greater shift of α-helix to aggregated β-sheet than *masseter* (relative to 25°C) (Figure 1a). This is hypothesized to be a consequence of the difference in thermostability of their myosin isoforms. However, at 60°C and 65°C in the muscle fibers, pH rather than temperature distinguishes the samples (Figure 1a–1b). At 60°C and 65°C, proteins of the muscle fibers of *masseter* and *cutaneous trunci* undergo greater conversion of α-helix into aggregated β-sheet at pH 6.5 compared to pH 5.6 (Figure 1a). Distinctively, proteins in the connective tissue from *masseter* and *cutaneous trunci* seem to be more sensitive to protein denaturation at their ultimate pH, 6.5 and 5.6, respectively, at all cooking temperatures (Figure 1b).

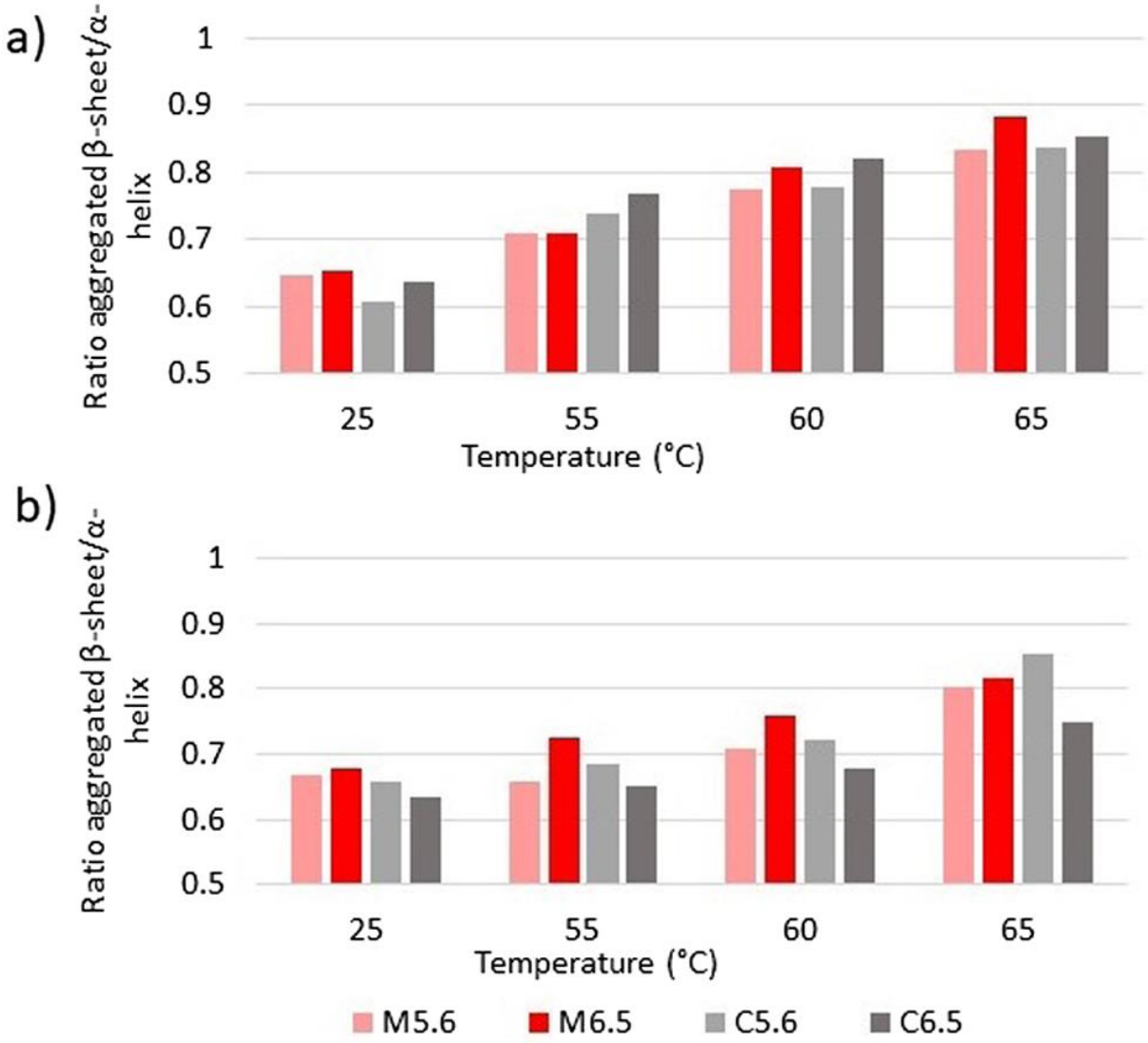

Figure 1.
Protein denaturation in a) muscle fibers; b) connective tissue. M- *masseter*, C-*cutaneous trunci*. N=5 for each data point.

IV. CONCLUSION

There are indications that muscle fiber proteins in *cutaneous trunci* show a greater thermal denaturation at 55°C than in *masseter*, which is most likely related to the different myosin isoforms and their thermal sensitivity. At all other conditions, pH rather than muscle type explains the differences in thermal protein denaturation of *masseter* and *cutaneous trunci*. These results might reflect differences in the water holding, texture, and digestibility of these muscles.

Keywords: beef, cooking, fiber type, pH, protein denaturation