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# THE EFFECT OF SHOCKWAVE PROCESSING ON MUSCLE PROTEIN STRUCTURE AND DIGESTIBILITY *IN VITRO*

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**Abstract** – The aim of this experiment was to investigate the effect of hydrodynamic shockwave (SW) processing on the muscle protein structure and digestibility *in vitro*. Beef brisket steaks were subjected to hydrodynamic SW (11 kJ/pulse) and were *sous-vide* cooked at 60°C for 12 hours, followed by *in vitro* gastric digestion. The protein native  $\alpha$ -helix structure of connective tissue and myofibers was modified after SW processing and SW-*sous-vide* cooking respectively. Acidic gastric digestion was found to have less effect on the molecular structure of myofibers of SW-*sous-vide* cooked meat in comparison with unprocessed meat. These structural changes may influence the meat protein digestive properties and hence have an impact on the nutritional value of the meat.

**Key Words** – Hydrodynamic Shockwave processing; *Sous-vide*; FT-IR microspectrometry; *in vitro* digestion

## I. INTRODUCTION

In recent decades, novel technologies such as hydrodynamic shockwave (SW) processing have been explored for meat tenderization, to improve the organoleptic and technological properties of meat. SW processing has been reported to alter muscle structure [1] and these changes are likely to influence the bioaccessibility of digestive enzymes to their substrates, which may affect the nutritional value of the meat products [2]. However, little or no information is available on the effect of SW processing on muscle protein molecular structure, or any effect on protein digestibility. Hence, the objective of this experiment was to study the effect of SW processing on bovine muscle protein molecular structure using FT-IR microspectrometry approach, with and without cooking and also after *in vitro* gastric digestion. The protein digestibility of the treated meat will be determined at a later stage.

## II. MATERIALS AND METHODS

Steaks obtained from 11 days *postmortem* Simmental beef briskets (21 – 22 months old) were exposed to hydrodynamic SW (intensity = 11 kJ/pulse, one pulse per step, continuous system), followed by *sous-vide* cooking at 60°C for 12 hours and simulated gastric digestion for 1 hour at pH 3 and 37°C in the presence of pepsin. Raw, cooked and digested samples were rapidly frozen using liquid nitrogen and were stored at -20°C for future analysis.

Blocks of 5 mm x 5 mm x 5 mm of all samples were cut transversely into 6  $\mu$ m thick sections using a cryostat (Leica, CM1950) at -20°C, which were then collected on a BaF<sub>2</sub> window. Infra-red spectra were acquired using a FT-IR microspectroscope (Thermo Scientific, Nicolet iN10), where at least 20 points of both myofibers (MF) and connective tissue (CT) were scanned for each sample with a 64 scans accumulation (15 X 15  $\mu$ m spatial resolution). The spectra were analyzed using Unscrambler X software (v10.4, Camo Software AS, Norway). Extended multiple signal correction (EMSC), followed by a second derivative treatment based on 9 Savitzky-Golay smoothing points were performed for spectra correction.

## III. RESULTS AND DISCUSSION

SW processing caused a change in the second derivatives spectra of the connective tissue at 1655 cm<sup>-1</sup> (figure 1(i)), indicating SW processing alters the native  $\alpha$ -helix structure [3] of connective tissue. After *sous-*

*vide* cooking, the intensity of 1655 cm<sup>-1</sup> band of the myofibers of SW treated samples was significantly lower than the control untreated meat ( $p < 0.005$ , figure 1(ii)), showing more severe protein denaturation of the treated sample during heat treatment. After an hour of *in vitro* gastric digestion, the intensity of 1655 cm<sup>-1</sup> band at the center of the SW cooked meat was significantly higher than the control untreated cooked meat ( $p < 0.05$ , Figure 1(iii)), showing the acidic gastric condition has more and faster impact on the untreated control sample, resulting in a higher extent of  $\alpha$ -helix denaturation of the myofibers in the latter. The determination of *in vitro* protein digestibility of SW-*sous-vide* cooked meat is now underway. The results will be correlated to the findings of the protein molecular structure.

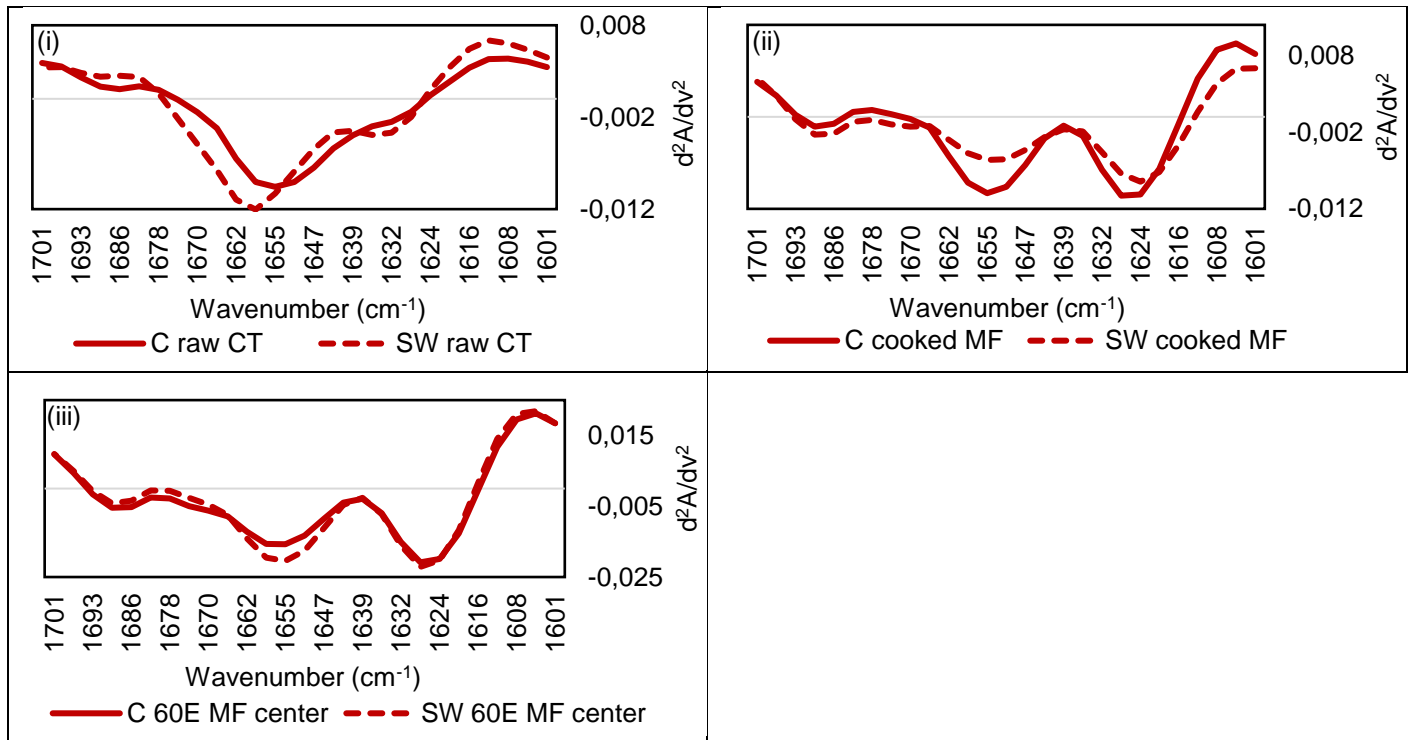


Figure 1. Amide I region second derivative spectra of (i) connective tissue of raw, (ii) myofibers of cooked and (iii) myofibers at the center of cooked, gastric digested (60E) control (C) and SW samples

#### IV. CONCLUSION

Hydrodynamic SW processing, with and without cooking, modify the protein secondary structure, which may affect the functional and nutritional quality of the meat and meat products.

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