MICROWAVING MEAT: ITS EFFECT ON MEAT QUALITY, PROTEIN STRUCTURE AND IN VITRO DIGESTIBILITY

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I. INTRODUCTION

Microwave (MW) heating has become popular due to the development of a microwave-assisted thermal processing unit that is designed to produce ready-to-eat meals. Advanced microwave technology, known as the Coaxially induced microwave pasteurisation and sterilisation (CiMPAS) system, uses industrial microwave frequency (915 MHz) and consists of a pressure vessel with circulating water at a controlled temperature. This equipment enables a rapid heating that exposes products to high temperatures. At present, studies on the impact of MW cooking on meat quality and ultrastructure are few, especially for red meat. Most research involving microwave processing for meat has been done using surimi gels or comminuted meat [1,2]. Furthermore, there is a lack of understanding of how MW processing affects meat protein digestibility. Therefore, this study was designed to determine the effect of MW heating involviing high-temperature intensive processing, versus the sous vide (SV) process, which requires a long-time and relatively low temperature, on the meat quality, protein structure, and in vitro protein digestibility. This objective was explored using SV and MW processes that produce the same level of cooked meat tenderness. We hypothesised that MW processing would lead to significant structural modification of meat proteins that might reduce the digestibility of proteins compared to the milder effects of SV cooking.

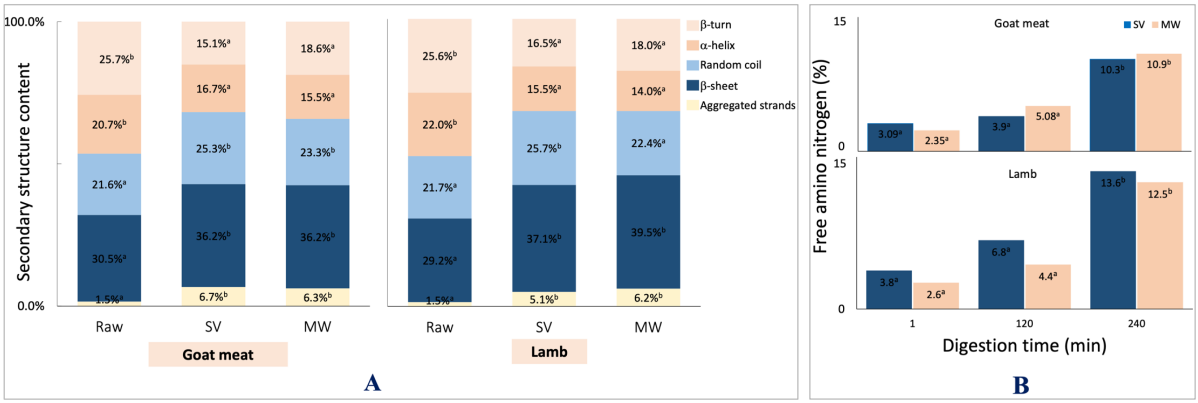
II. MATERIALS AND METHODS

The lamb and goat *biceps femoris* were subjected to MW or SV treatments. Six animals of each species were used. The CiMPAS was used to investigate the effects of MW processing on meat. Vacuum-packed samples were placed inside the MW heating chamber and flushed with water; samples were exposed to MW for four consecutive passes at a speed of 100 cm/min. The MW treatment was done for 5 min, and another 20 min for cooling at 60 °C. For the SV process, packed meat was cooked at 60 °C for 9 hrs; this SV condition gave the same tenderness as meat processed using MW after a series of preliminary experiments. The tenderness (Warner-Bratzler Shear Force (WBSF)), color, and cooking loss was determined, and meat ultrastructure was examined using Transmission Electron Microscopy (TEM). The protein structure (hydrophobicity, aggregation) and secondary structure using Fourier transform infrared (FTIR) spectroscopy were analysed. The digestion experiment was done using static digestion model following the INFOGEST protocol for static in vitro digestion in a double-jacketed glass reactor [3,4]. The protein digestibility was assessed by free amino nitrogen assay and digest protein profile was examined using SDS-PAGE. The Statistical analysis was done using the Minitab General Mixed Model with multiple comparison analysis using the Tukey test at a 95 % confidence interval.

III. RESULTS AND DISCUSSION

The 5 min MW treatment led to a rapid rise in the meat internal temperature of up to 120 °C for lamb and 110 °C for goat meat. The process produced cooked meat with texture (WBSF) equivalent to their control SV cooked counterparts; goat meat had tenderness from 42.8-43.8 N and lamb from 21.5-23.1 N. However, MW meat had higher cooking loss, and a lighter-brown color between MW and SV treated samples. These observations can be attributed to the fast and high-temperature MW process that intensely denatured myoglobin [5] and rapidly mobilized bound water from meat tissue [6]. In addition,

TEM results showed more pronounced ultrastructural damage for MW meat than SV; with higher myofibrillar shrinkage and disintegration, and widening of Z disks due to the high-temperature process. The MW samples also had higher protein hydrophobicity. Secondary structure analysis showed a marked increase in β-sheet and random coil with a significant reduction in α-helix and β-turns (Figure 1A) for both treatments. Although both SV and MW led to different protein hydrolysis patterns as determined using SDS-PAGE, the overall free amino nitrogen release after in vitro digestion was not significantly different ($p > 0.05$) for both samples.



[a-b]Values within a treatment not having common superscripts differ significantly ($p < 0.05$) (Figure 1A).
[a-b]Values in a given digestion time not having common superscripts differ significantly ($p < 0.05$) (Figure 1B).

Figure 1. Secondary structure content (**A**) of raw, sous vide (SV), and microwave (MW) samples and free amino nitrogen (**B**) of the digested SV and MW meat after 1, 120 (gastric phase), and 240 min (gastro-intestinal phase).

IV. CONCLUSION

The MW sample results in high moisture loss which should be addressed when designing pre-packed meals using the MW. High-temperature MW processing can modify meat protein structure differently from mild SV, but with the same tenderness level, both processes can lead to the same overall protein digestibility in terms of the protein hydrolysis with different protein digestion patterns.

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