EFFECT OF MICROWAVE HEATING ON SHEAR FORCE AND MICROSTRUCTURE OF YAK MEAT

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I. INTRODUCTION

Yak meat has gained growing demands in China. Improvements in processing or self-life technologies are highly demanded for better quality of yak meat products. Microwave heating through the conversion of electromagnetic energy to thermal energy [1] has potential advantages in meat processing. However, research on the effects of microwave cooking on yak meat is mainly focused on the change of composition such as protein, fats, and cooking loss before and after microwave treatment. The effect of microwave heating at various conditions (power and time) on yak meat tenderness and microstructure has not been reported. The objective of this study was to evaluate the shear force and microstructure changes of microwave cooked yak in comparing with conventional water bath cooking.

II. MATERIALS AND METHODS

Yak meat samples were collected from the *longissimus* of three healthy yaks (age 3) after slaughter, and cut into dimension of 3 cm × 3 cm × 1.5 cm samples, were subjected to microwave cooking or water bath cooking. Samples were placed at the optimum site with best heating efficiency, for further analysis. Boiled or microwaved yak meat was sliced (0.5 cm^3 thickness), and immediately fixed in 4 % paraformaldehyde for 4 days (4 °C). The samples were then waxed, paraffin embedded and H&E stained. The microstructure of yak meat was observed using a reverse-phase microscopy (IX71, Olympus, Japan). The shear force of yak meat samples were determined by a texture analyzer (TA. XT plus, Stable Micro Systems, UK), equipped with a HDP/BSW probe. The statistic difference was evaluated by One-Way ANOVA using SPSS 21.0 software.

III. RESULTS AND DISCUSSION

Optimization of microwave cooking protocol The heating efficiency at 9 selected sites (distributed as Fig. 1) in microwave chamber were evaluated under three power settings (high, medium, and low) for various heating time (80-310 seconds). The differences in changes of temperature at 9 sites demonstrated that the output energy in microwave chamber is not uniformed (Fig. 2). The organoleptic changes of yak meat showed very different (Fig. 3). Raw yak meat samples were still bloody and not edible after cooking under high power (100 %) for 20 and 25 seconds, and under medium (80 %) for 30 and 40 seconds, under low (60 %) for 50 and 60 seconds. Site #2 shows the highest heating efficiency. Therefore, meat samples were placed at site #2 of microwave chamber in the study.

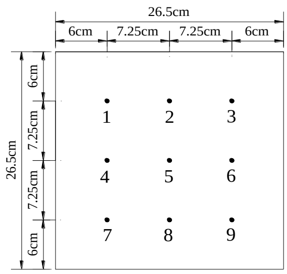

Fig.1 Distribution of heating sites in microwave chamber

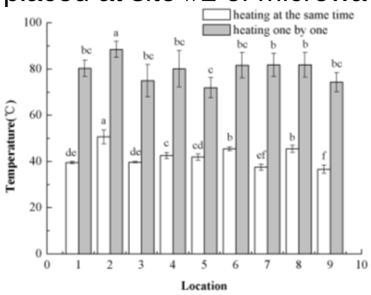

Fig.2 Testing result of thermal efficiency at different location

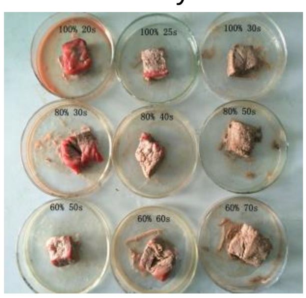

Fig.3 Appearance changes of yak meat after microwave heating treatment

Shear force As the microwave heating time extends, the shearing force increases significantly (P <0.05) among same power sitting groups (Table 1). The low-power microwave processing was better for tenderness of yak meat when the heating time was constant. All microwave cooked yak meats have lower shearing force compared to water cooked. Higher tenderness may due to the rapid thermal shrinkage of muscles and better collagen solubilization during microwave cooking in a short time [2].

Table 1 Shear force of Yak meat after microwave processing

Treatment group		Shear force（g）	Treatment group		Shear force（g）	Treatment group		Shear force（g）
P-100%	30s	26503.41±12.82^{b}	P-80%	50s	27083.84±190.39^{bc}	P-60%	70s	27024.70±0.00^{c}
	40s	26513.15±540.08^{b}		60s	26245.41±190.39^{c}		80s	27965.44±81.19^{c}
	50s	27111.48±465.65^{ab}		70s	27350.72±659.56^{ab}		90s	31041.22±715.06^{b}
	60s	28166.65±675.42^{a}		80s	29289.868±620.46^{a}		100s	32200.51±65.29^{a}
boiling water		32331.68±346.60						

Note: Data within the same column followed by different superscripts are significantly different (P< 0.05).

Microstructure After microwave or boiling water cooking, the microstructures of yak meat were changed remarkably(Fig. 4). Compared to the raw meat, there were enlarged gaps between meat fibers and endomysial tubes. Microwave cooked yak meat showed less muscle fiber structure damage than water bath cooking. This suggests that yak meat cooked by microwave yields higher tenderness. As cooking time extended under same microwave power sittings, yak meat shown more gaps and fractures between muscle fibers. Therefore, choosing relatively high and short time microwave condition is ideal for retaining optimum tenderness and chewiness of yak meat.

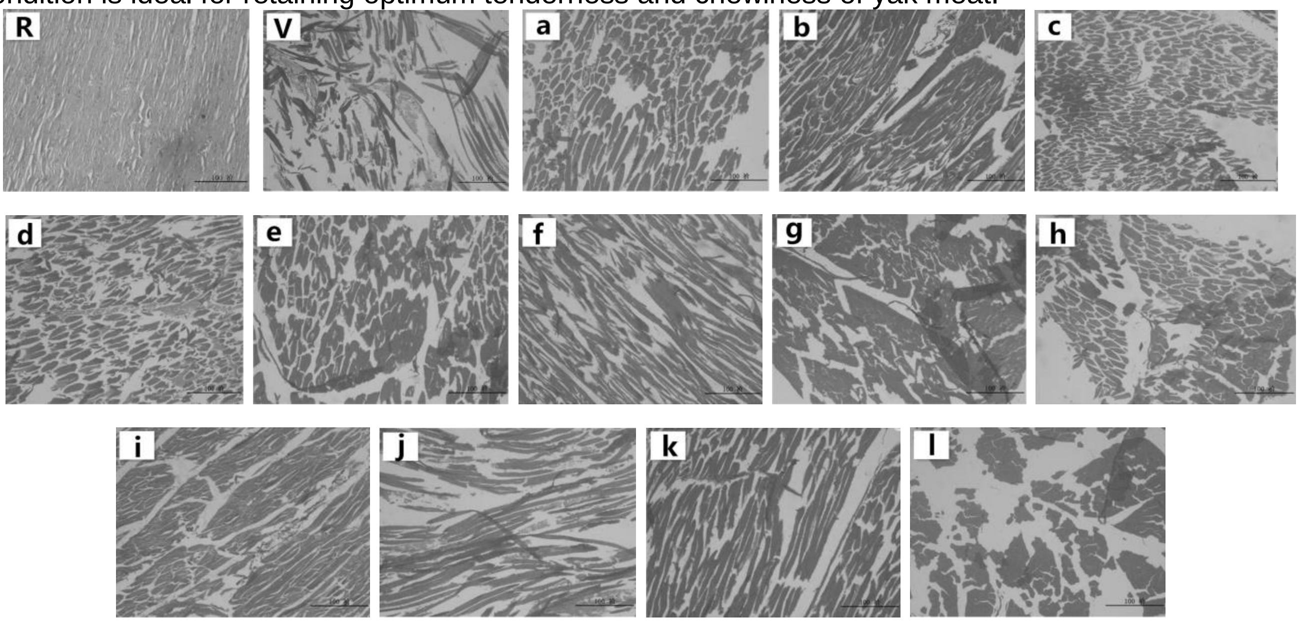

Fig. 4 Microstructure of yak meat cooked by microwave treatments（10 ×）

Footnotes: R: raw meat; V: Boiled in water; a: high (700 W; 100%), 30 sec; b: high (700 W; 100%), 40 sec; c: high (700 W; 100%), 50 sec; d: high (700 W; 100%) 60 sec; e: medium (560 W; 80%), 50 sec; f: medium (560 W; 80%), 60 sec; g: medium (560 W; 80%), 70 sec; h: medium (560 W; 80%), 80 sec; i: low (420 W; 60%), 70 sec; j: low (420 W; 60%), 80 sec; k: low (420 W; 60%), 90 sec; l: low (420 W; 60%), 100 s.

IV. CONCLUSION

Microwave cooking tends to lower the shearing force and improve the microstructure. Therefore, microwave could be a promising cooking method for yak meat products and the ideal condition should be higher power outputs for short time.

ACKNOWLEDGEMENTS

This research was financially supported by National “Twelfth Five-year” Science & Technology support program (Project No: 2015BAD29B02) and Sichuan Provincial Major Science and Technology Program (Project No: 2016NZ0005).

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