EFFECT OF MICROWAVE HEATING AND MARINATION ON COLOUR AND TENDERNESS OF *SEMIMEMBRANOSUS* AND *SEMITENDINOSUS* MUSCLES FROM FRIESIAN MATURE COWS

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***Abstract*—*Semimembranosus* (SM) and *Semitendinosus* (ST) muscles from 8 mature cows were used to evaluate the effect of power of heating, final meat temperature, and marination on beef quality using a domestic microwave (MW) oven. Muscles were cut into roasts assigned to either a control (CON: no marinade, right-carcass side) or a marination-treatment (MAR: left-carcass side) and cooked using combinations of 2 MW powers (250 vs. 900W) and 2 final temperatures (60 vs. 80°C). There was no power effect on tenderness of SM and ST. Cooking at 900W resulted in lower redness in SM and lower yellowness in ST muscle compared with 250W. Cooking to an internal temperature of 80°C showed lower SM tenderness and lower SM and ST redness than 60°C. Marination improved tenderness and decreased redness in both cooked muscles. High and low MW power can be used satisfactorily for cooking SM and ST muscles. Marination of beef from mature cows and lower final meat temperature improved cooked beef quality using microwave particularly in the SM muscle.**

***Index Terms*—beef, marination, microwave, quality.**

I. INTRODUCTION

Enhancing the flavor, tenderness and consumer acceptance of whole-muscle beef cuts from the round offers the opportunity to market value added beef products. The beef industry has recently adopted moisture enhancement (brine injection) of fresh meat for commercial use to help ensure product consistency, juiciness and tenderness. In addition, microwave cooking became popular because of its rapid speed of food preparation and amount of energy saved in homes, food processing, and food service operations. Meat undergoes changes in its physical properties (i.e. colour, texture) and it is subjected to chemical reactions (i.e. protein denaturation, Maillard reaction) during cooking which influence its final quality and acceptability (Chiavaro, Rinaldi, Vittadini & Barbanti, 2009). Korschgen, Baldwin and Snider (1976) indicated that either high- or low- powered MW equipment can be used satisfactorily for cooking longissimus muscle from beef. However, there is limited information on the effect of MW cooking on other beef muscles such as SM and ST. The aim of this work was to evaluate the effect of power of heating, final internal temperature and marination using microwave cooking on quality of *Semimembranosus* and *Semitendinosus* muscles from Friesian mature cows.

II. MATERIALS AND METHODS

A. Materials

Beef rounds were obtained at 24 h postmortem from the right and left side carcasses (EU Conformation: O and Fatness: 2) of 8 Friesian mature cows (5.5 years old) in a commercial slaughter and packing facility. Vacuum packaged cuts were transported to the IRTA meat laboratory and the SM and ST muscles were removed from each round. The left side SM and ST muscles were injected using a Inject-Star BI 13B multi-needle injector (Dordal, SA, Perpetua de Mogoda, Barcelona) with a brine to equal 10% of raw muscle weight (10% wt/wt), while the right side muscles were used as a control (no marinade). The brine solution used for injection contained 5,6% of salt, 4% of sodium lactate, 5% of lactose and 0.5% of ascorbate. Total tumbling time after injection was 2 h at a rotation speed of 7 rpm with continuous tumbling during 15 min. followed by cycles of 5 min. tumbling plus 10 min. of relaxation during 1 h 45 min.

All ST and SM muscles were cut into 4 samples each of 10x4x3cm and 15x5x3cm, respectively. Meat samples were vacuum packaged, frozen and stored at -20ºC until analysis. Before cooking, samples were thawed submerged in H2O in a container with crushed ice overnight in a cooler (2±2°C). Thawed samples were placed in H2O at 18°C during 45 min. for ST (10x4x3 cm) and 60 min. for SM (15x5x3 cm) to reach meat temperature of 18°C before starting microwave cooking.

B. Microwave cooking

Six or eight optical probes (FOT.L/1.5m; FISO Technologies Inc., Canada. Accuracy ± 0) were alternatively inserted in ST (10x4x3 cm) and SM samples (15x5x3 cm), respectively. Each sample was placed in a tray at the centre of a turntable domestic microwave oven with a frequency of 2.45 GHz. The microwave oven was provided with an electronic interface Microwave WorkstationTM from FISO Technologies Inc.

Four cooking conditions were applied using 2 MW powers (250 vs. 900W) and 2 final temperatures (60 vs. 80°C): 250W60, 250W80, 900W60, 900W80. Microwave was stopped when the central deep probe (SM: B-D and C-D, ST: B-D, Figure 1) reached the target temperature (60 or 80°C). After cooking the meat sample was placed on ice and cooled down until internal temperature reached 33°C.

C. Instrumental tenderness

After cooking and cooling, ST and SM samples were cut into 2x1x1 cm parallelepiped samples (6 for ST and 16 for SM, Figure 1) for instrumental texture analysis. Warner-Bratzler shear force (WBSF) was measured using a texture analyzer Alliance RT/5 (MTS Systems Corp., Eden Prairie, MN, USA) equipped with a Warner-Bratzler blade with crosshead speed set at 2 mm/s.

D. Instrumental colour

Lightness, redness and yellowness (L*, a*, b*) were measured using a Spectrophotometer (Minolta, CM-2002) before and after cooking on one end of the sample at 6 points.

E. Statistical analysis

Data were analyzed as a factorial design with power (250 vs. 900W), final internal temperature (60 vs. 80°C), marination (control vs. marinade) and two- and three-way interactions in the model using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC). Sample raw weight was included as covariate in the model.

III. RESULTS AND DISCUSSION

INSTRUMENTAL TEXTURE (WBSF)

Semimembranosus muscle

There were no interactions ($P>0.05$) among power, temperature or marination effects on Warner-Bratzler shear force for the SM muscle (Figure 1). There was no effect ($P>0.05$) of power on meat tenderness. Shear force values were higher ($P<0.05$) for SM cooked to 80 than 60°C (5.53 vs. 5.05 kg, respectively). Marination reduced shear force improving meat tenderness compared with non-marinated beef (4.69 vs. 5.89 kg, respectively).

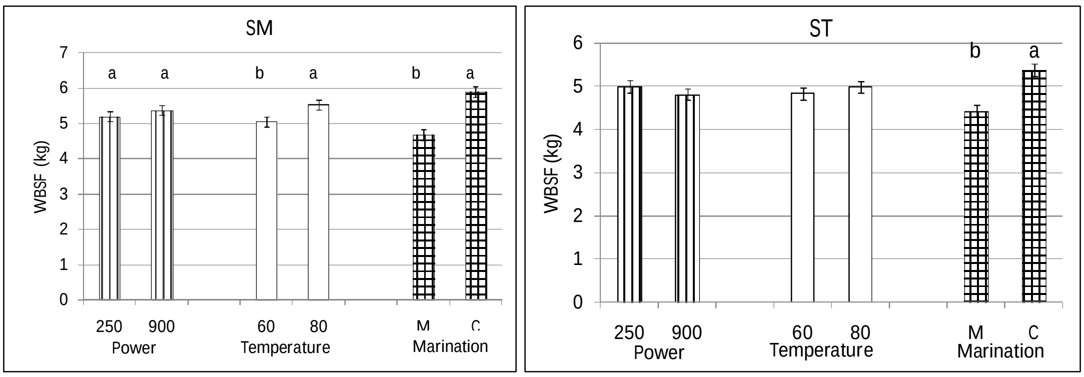

Figure 1. Effect of power (250 vs. 900W), temperature (60 vs. 80ºC), and marination (M: marinated vs. C: control) on Warner-Bratzler shear force (WBSF, kg) for SM and ST muscles.

Semitendinosus muscle

There were no interactions ($P>0.05$) among power, temperature or marination effects on Warner-Bratzler shear force for the ST muscle (Figure 1). Similar to the SM muscle, microwave power had no effect ($P>0.05$) on ST instrumental tenderness. However, final meat temperature did not show an effect ($P>0.05$) on meat tenderness. Marination also reduced shear force improving meat tenderness in the ST muscle compared with non-marinated beef (4.43 vs. 5.38 kg, respectively).

Shear force values were lower than 6 kg which is unusually low for mature cows. However, marination reduced shear force by 25.6 and 21.4% in SM and ST, respectively, improving tenderness in both muscles. The positive effect of marination on beef tenderness is well documented. However, there is limited information on the effect of marination on beef quality when lower values cuts are cooked using microwave.

INSTRUMENTAL COLOR (L*, a*, b*)

Non-uniform microwave heating resulted in heterogeneous cooked colour within each roast and this gradient makes it difficult to measure colour with accuracy.

Semimembranosus muscle

There was interaction (P<0.05) between power, temperature and marination for colour lightness (L*). However, there is no clear power, temperature or marination effect on L* values. Non-marinated samples cooked at 250W and 60°C had lower L* than all other treatments, indicating that at mild cooking power and temperature conditions, control samples may result in a darker colour compared with other treatments. There was no interaction (P>0.05) among power, temperature and marination for colour redness (a*). Samples cooked at the lower power, lower temperature and non-marinated resulted in more red colour than samples cooked at the higher power, higher temperature and marinated, respectively. There was no effect of power, temperature or marination on colour yellowness (b*, data not shown).

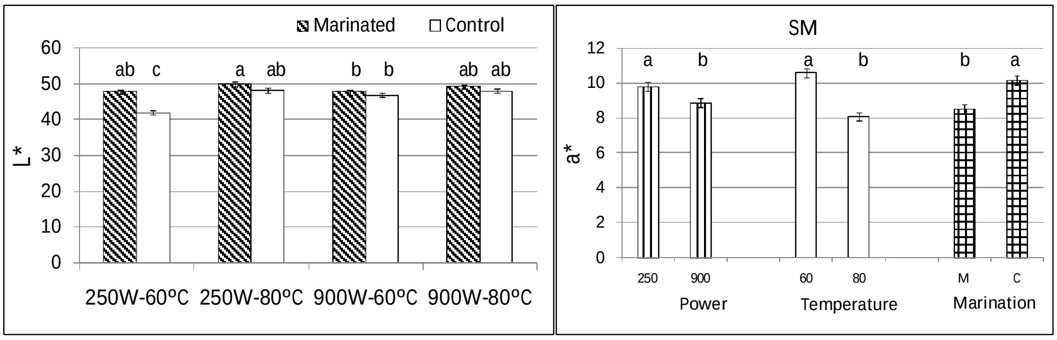

Figure 3. Effect of power, temperature and marination on colour lightness and redness (L* and a*) for SM muscle.

Semitendinosus muscle

There was no effect of power, temperature or marination on colour lightness (L*, data not shown). There was interaction (P<0.05) between power, temperature and marination for colour redness (a*). Control ST was more red than marinated beef when cooked at 900W and 80ºC, but there were no differences between marinated and control treatments in redness at other cooking conditions. Beef was more red for control ST when cooked at 60 than 80ºC using the lower power. When samples were cooked at the higher power, redness was higher for marinated ST when cooked at 60 than 80ºC. There were no interactions (P>0.05) between power, temperature and marination for colour yellowness (b*). Samples cooked at lower power, lower temperature, and non-marinated resulted in more yellow colour compared with samples cooked at higher power, higher temperature, and marinated, respectively.

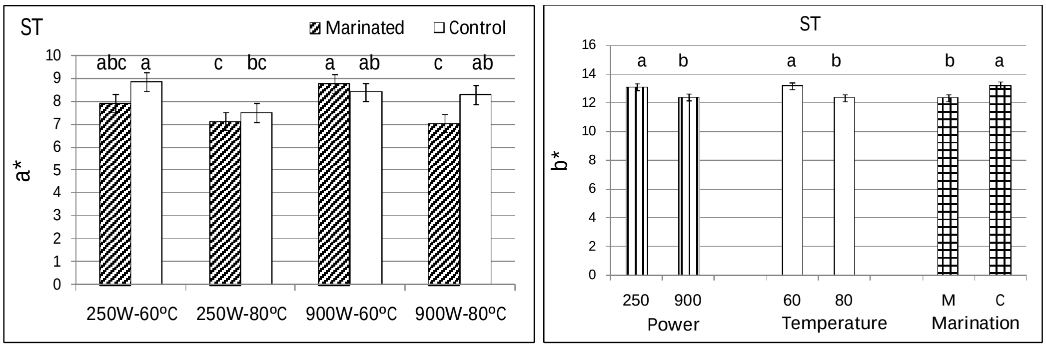

Figure 4. Effect of power, temperature and marination on colour redness and yellowness (a* and b*) for ST muscle.

IV. CONCLUSION

High and low microwave power can be used satisfactorily for cooking Semimembranosus and Semitendinosus muscles. Marination of beef from mature cows and lower final meat temperature improved cooked beef quality using a domestic microwave particularly in the Semimembranosus muscle.

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