Effect of temperature and cooking time on the toughness of previously tumbled beef cuts

Konan Charles N'gatta, Raphael Favier, Jacques Rouel, Alain Kondjoyan, Dominique Gruffat, Pierre-Sylvain Mirade

UR QuaPA, INRAE, Theix, France

Introduction: Tumbling is a mechanical tenderizing process which promotes the degradation of meat tissues and a better penetration of the brine ingredients in the meat. This results in a better juiciness and tenderness of meat (Pietrasik & Shand, 2004; Siró et al., 2009). Tenderness, juiciness and flavour are the main factors that determine consumer satisfaction and acceptance of cooked meat. These quality attributes highly depend on the cooking conditions (temperatures, times and methods) which influence the meat toughness and cooking losses (Christensen et al., 2000; Aaslyng et al., 2003; Dominguez-Hernandez et al., 2018). This study aimed at evaluating the combined effect of temperature and cooking time on the toughness of meat pieces that were previously tumbled.

Materials and methods: Twelve Semitendinosus muscles extracted from Charolais cows aged of 52 +/- 6 months were matured under vacuum at 4°C for 21 days, before being frozen until use. Before each experiment, the muscles were thawed for 3 days at 4°C, before being cut into meat pieces of 18 cm in length and 6.5 cm in diameter. The meat pieces were then tumbled using a tumbling simulator (Daudin et al., 2016), undergoing a compression rate of 40% and 9500 consecutive compression cycles, i.e. 12 hours of tumbling. Each tumbled and control (not tumbled) meat piece was cut into six 3 cm-thick steaks numbered from 1 to 6, from proximal to distal end, respectively. The steaks were vacuum-packed in polyethylene bags and heated in a water bath set at 50°C, 60°C and 80°C. The steaks in positions 1, 3, 5 and 2, 4, 6 were cooked for 1h (time necessary to reach the equilibrium in temperature in the steak) and 4h (time necessary to reach the equilibrium water content in the steak), respectively. Each experiment was performed three times. After cooking, the steaks were cooled in ice water for 10 min. A weight difference before and after the heat treatment was used to calculate the cooking losses. Each steak was then cut into 10 samples which dimensions were 1 x 1 x 3 cm3. The mechanical resistance of each meat sample was evaluated from a shear test realized with an Instron device equipped with a shear cell developed by Salé (1971). The shear forces corresponded to the maximum forces determined from the force-deformation curves.

Results: Meat structure damages due to tumbling decreased the toughness of the meat pieces, whatever the cooking conditions applied. Tumbling and heat temperature had a significant effect on shear force ($P < 0.001$). The Tumbling process decreased shear forces values by 20 % compared to control samples. Cooking meat pieces up till to 60°C and 80°C decreased their shear forces by 40% compared to those cooked up till 50°C. Increasing cooking temperature and time led to higher cooking losses.

Conclusions: The reduction in the toughness of raw meat pieces, caused by tumbling, persists after cooking, but depends on the cooking temperature. Indeed, despite tumbling, meat pieces heated at 50°C are tougher than those heated at 60°C and 80°C. So, cooking tumbled meat pieces at temperatures close to 60°C seems to be the best compromise between reducing toughness and limiting cooking losses.

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Literature:

Salé, P. (1971). Evolution de quelques propriétés mécaniques du muscle pendant la maturation. Proceeding of the 17th European Meeting of meat research Workers, Bristol, 6, 11.

Aaslyng, M. D., Bejerholm, C., Ertbjerg, P., Bertram, H. C., & Andersen, H. J. (2003). Cooking loss and juiciness of pork in relation to raw meat quality and cooking procedure. Food Quality and Preference, 14(4), 277-288.

Christensen, M., Purslow, P. P., & Larsen, L. M. (2000). The effect of cooking temperature on mechanical properties of whole meat, single muscle fibres and perimysial connective tissue. Meat Science, 55(3), 301-307.

Daudin, J.-D., Sharedeh, D., Favier, R., Portanguen, S., Auberger, J.-M., & Kondjoyan, A. (2016). Design of a new laboratory tumbling simulator for chunked meat: Analysis, reproduction and measurement of mechanical treatment. Journal of Food Engineering, 170, 83-91.

Dominguez-Hernandez, E., Salaseviciene, A., & Ertbjerg, P. (2018). Low-temperature long-time cooking of meat: Eating quality and underlying mechanisms. Meat Science, 143, 104-113.

Pietrasik, Z., & Shand, P. J. (2004). Effect of blade tenderization and tumbling time on the processing characteristics and tenderness of injected cooked roast beef. Meat Science, 66(4), 871-879.

Siró, I., Vén, C., Balla, C., Jónás, G., Zeke, I., & Friedrich, L. (2009). Application of an ultrasonic assisted curing technique for improving the diffusion of sodium chloride in porcine meat. Journal of Food Engineering, 91(2), 353-362.