## Effect of tumbling time on raw beef of intermediate initial tenderness

Konan Charles N'gatta[1], Raphael Favier[1], Jacques Rouel[1], Alain Kondjoyan[1], Annie Venien[1], Thierry Astruc[1], Dominique Gruffat[2], Pierre-Sylvain Mirade[1]

[1] UR QuaPA, INRAE, Theix, France
[2] UMRH, INRAE, Theix, France

**Introduction:** One of the main challenges for meat industry is to provide consumers with high quality meat products. For bovine meat, tenderness is the most important quality criterion and determines consumer satisfaction. There are two main processing methods traditionally used for mechanically tenderising meat: blade tenderisation and mechanical tumbling. During tumbling, the meat pieces undergo mechanical deformations that disrupt muscle fibres and connective tissue, which leads to an improvement in meat and meat products tenderness (Cassidy et al., 1978; Theno et al., 1978; Pietrasik & Shand, 2004). Mechanical deformation of meat pieces is closely linked to tumbler size and tumbling process duration (Mirade et al., 2020). Daudin et al. (2016) have developed a laboratory tumbling simulator to control and measure mechanical deformations of muscles during tumbling. These authors showed that this device can reproduce the deformation rates occurring in industrial tumblers of various size. The aim of this study was to evaluate the effect of extended tumbling duration on toughness of raw beef cuts of intermediate initial tenderness.

**Materials and methods:** Fifteen Semitendinosus (ST) muscles extracted from Charolais cows aged of 52 months +/- 8 months and previously matured under vacuum at 4°C for 21 days, were cut into pieces 6.5 cm in diameter and 20 cm in length. Five different mechanical treatments, i.e. NT (untreated), T1 (3 hours, corresponding to 2500 consecutive compression cycles), T2 (7h, 6000 cycles), T3 (12h, 9500 cycles) and T4 (16h, 13000 cycles), were applied to the meat cuts by using the laboratory tumbling simulator developed by Daudin et al. (2016), with a compression rate of 40%. Each mechanical treatment was performed three times. Compression tests were realized to assess the textural properties of the treated pieces of raw meat. Stresses at 20 and 80% of the maximum compression of samples were recorded to assess the muscle fibres and connective tissue toughness, respectively (Campo et al., 2000). Muscle fibres degradation was evaluated with a microscopy technique with the analysis of hematoxylin–eosin–saffron (HES) staining of sections taken from two different depths of tenderised meat pieces, i.e. at the periphery and centre.

**Results:** Increasing tumbling duration reduced toughness of raw meat, resulting in a reduction ($P < 0.001$) of more than 60% of the initial toughness of the muscle fibres, from treatment T2 and a reduction ($P < 0.001$) of 40% of the initial toughness of the connective tissue, from T3. Microscopically, increasing tumbling time reduced the extracellular spaces, increased muscles fibres disruption and enhanced development of amorphous areas where distinction of muscle fibres was impossible. Moreover, muscle fibres disruption was more pronounced in centre than in periphery of tumbled meat pieces.

**Conclusions:** Increasing tumbling time decreases toughness of raw beef muscles initially presenting an intermediate tenderness. Tumbling process could therefore be used to improve the tenderness of this type of meat cuts. We need now to check if this improvement of meat tenderness still persists after cooking.

**Acknowledgements and Financial support statement:** This work was co-funded by the Auvergne-Rhône-Alpes region through the "Contrats de Plan Etat-Région 2015-2020" project and by "Consortium de Recherches Auvergne-Rhône-Alpes pour la VIANDE de ruminants"

**Literature:**

Campo, M. M., Santolaria, P., Sañudo, C., Lepetit, J., Olleta, J. L., Panea, B., & Albertı- , P. (2000). Assessment of breed type and ageing time effects on beef meat quality using two different texture devices. Meat Science, 55(4), 371-378.

Cassidy, R. O., Ockerman, H. W., Krol, B., Roon, P. S., Plimpton, R. F., & Cahill, V. R. (1978). Effect of tumbling method, phosphate level and final cook temperature on histological characteristices of tumbled porcine muscle tissue. Journal of Food Science, 43(5), 1514-1518.

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.

Mirade, P. S., Portanguen, S., Sicard, J., De Souza, J., Musavu Ndob, A., Hoffman, L. C., Goli, T., & Collignan, A. (2020). Impact of tumbling operating parameters on salt, water and acetic acid transfers during biltong-type meat processing. Journal of Food Engineering, 265, 109686.

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.

Theno, D. M., Siegel, D. G., & Schmidt, G. R. (1978). Meat Massaging: effects of salt and phosphate on the microstructural composition of the muscle exudate. Journal of Food Science, 43(2), 483-487.