SALT EFFECTS ON BEEF FRESH SAUSAGE ULTRASTRUCTURE

T. Astruc*[1], R. Labas[1], B. Gaillard-Martinie[2], R. Taylor[3] J.L. Martin[4] and J.L. Vendeuvre[4]

[1]. Unité Qualité des Produits Animaux, INRA de Theix 63122 St Genés Champanelle, France. [2]. Plateau Technique Microscopie Electronique INRA de Theix. [3]. EWOS Innovation, 4335 Dirdal, Norway. [4]. CTSCCV, 94700 Maison Alfort, France. Email : astruc@clermont.inra.fr

Keywords: beef, minced meat, salt, ultrastructure

Introduction

The aim of this study was to characterise the salt and process effects on meat ultrastructure in beef fresh sausage and check if that level of magnification might help assessing it in meat preparations or in meat products according to the definitions laid down by EU-regulation (EC) N° 853/2004 Annex I- under 115 and 71 whether the process undergone was insufficient or not to modify the internal muscle fibre structure.

Materials and Methods

1) Meat sausage processing

Minced meat was prepared from beef chuck (fattening mark = 3) with a 3.2 to 3.5mm diameter mincing grid at 0°C temperature. Fat in the mixture was less than 20% and the ratio of collagen/protein was 15. Three salt concentrations were tested in the mixture: the first mixture without NaCl addition (control), the second including 8g of NaCl per kg of minced meat (0.8 % salt) and the last with 16g of NaCl per kg of minced meat (1.6 % salt). Beef minced meat was stored for 24 h at 0°C before examination.

2) Sample preparation

Five sausage samples of about $5mm^3$ were taken for each preparation and fixed overnight at 4°C by immersion in 2.5 % glutaraldehyde in 0.1M sodium cacodylate buffer, pH 7.2. Small blocks (1 to $3mm^3$) were post-fixed in 1% osmium tetroxide in the same sodium cacodylate buffer for 1 hour at ambient temperature. The blocks were dehydrated through an ethanol gradient and embedded in epoxy resin (TAAB, Eurobio France). Semi-thin sections (1.5µm) were stained with toluidine blue and observed with an optical microscope (Reichert Jung). An area presenting muscle fibres in a longitudinal state was selected for ultrastructure observations. Ultra-thin sections (90nm) were stained with uranyl acetate and lead citrate, and observed with a Morgagni electron microscope using a 90KV acceleration voltage. Micrographs were made using a numeric camera system coupled with the microscope.

Results and Discussion

1) Mincing effects on fibre and myofibril morphology

Mincing had an effect on fibre structure as shown in Figure 1A where changes of orientation of the fibres are seen. At the ultrastructural level, myofibrils can keep their normal alignment (1B) or show undulation or torsion of the sarcomeres (1C). At low magnification (1A), torsion due to mincing is evident, that at higher magnification (1C) is seen as loss of normal A and I band definition.

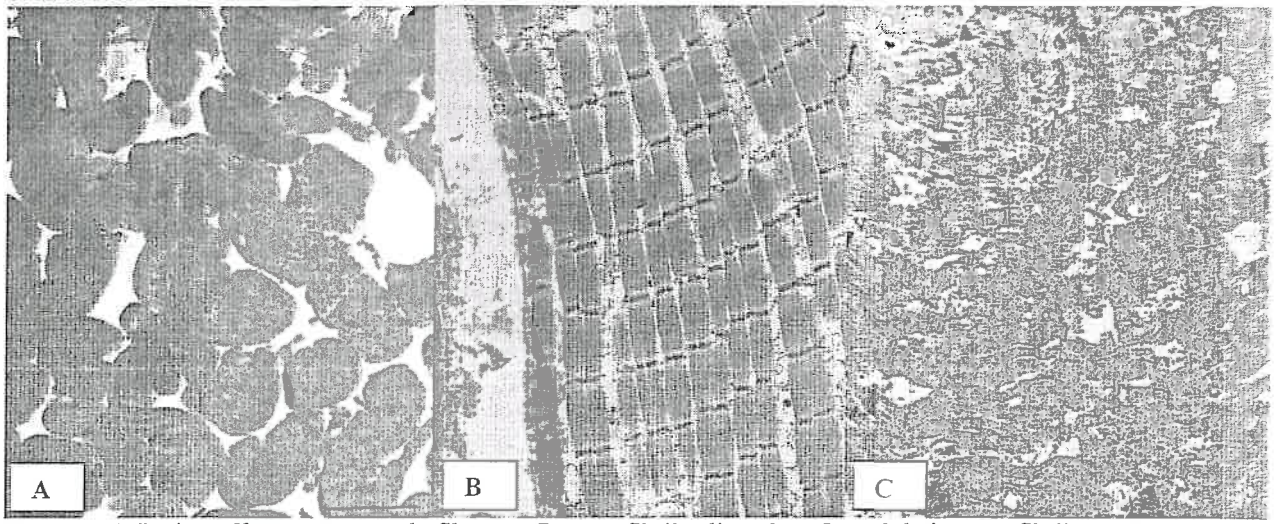

Figure 1: Mincing effect on A: muscle fibres. B : myofibrils aligned. C: undulating myofibrils.

2) Salt effects on ultrastructure

A 0.8% salt concentration didn't modify the general structure of the fibres (D, 3 fibres are seen) and myofibrils (D and E) but had some effect on the sarcomeres, espescially along the Z line as shown by arrows on the micrograph E.

A 1.6 % salt concentration led generally to heterogenous changes. In micrograph F, the general morphology of the myofibrils was preserved with Z and M lines still visible (about 50% of the oberved fields). However, the Z line width diminished and the "alignment organisation" of the myofilaments is less evident. In the last micrograph (E), the ultrastructure of the myofibrils was destroyed with an important loss of the integrity of the sarcomere and of the Z lines (50% of the observed fields).

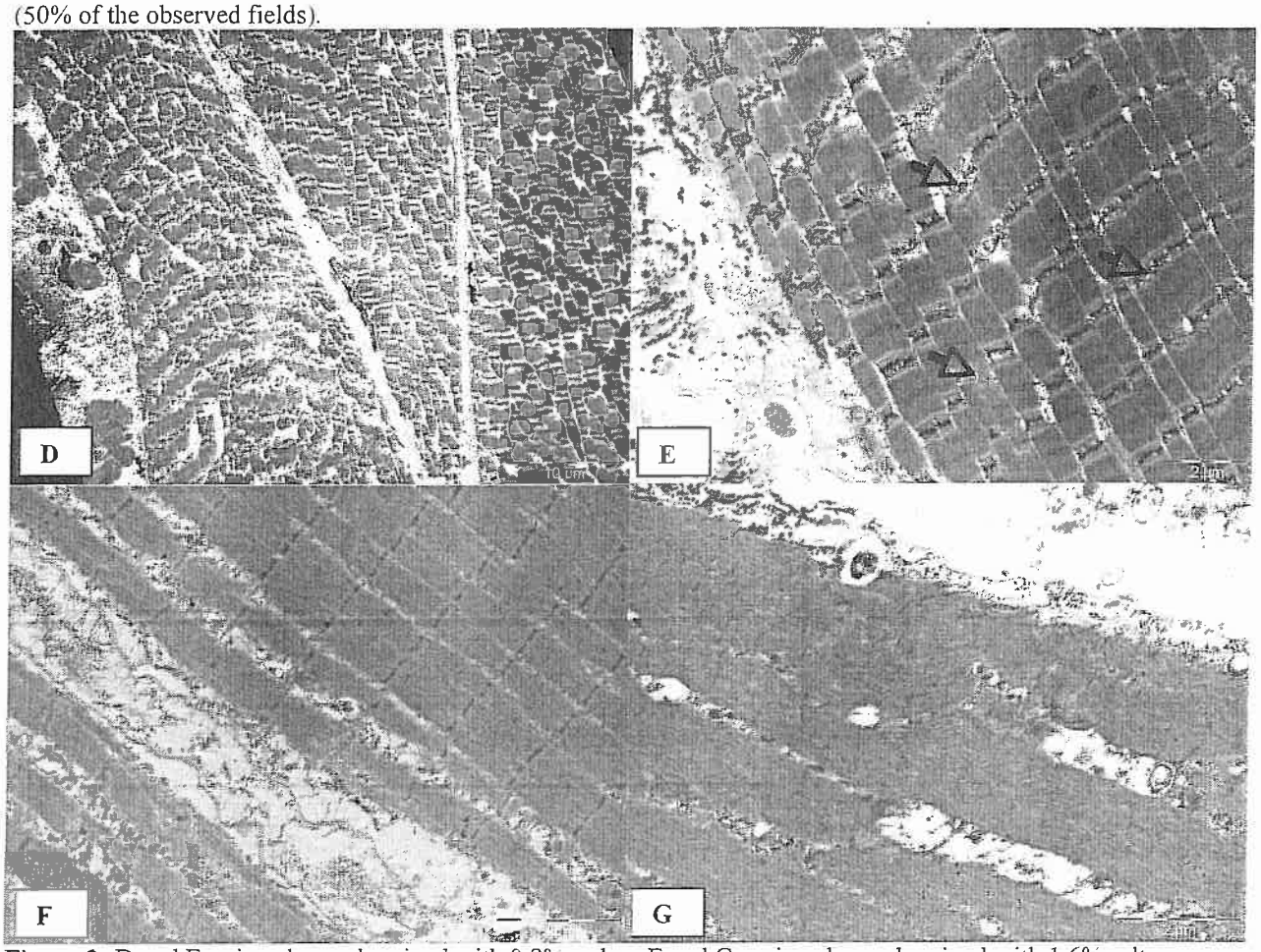

Figure 2: D and E: minced muscle mixed with 0.8% salt F and G : minced muscle mixed with 1.6% salt.

According to Offer and Knight (1988) and Ripoche *et al.* (2001), the main results indicate that salt modification of sarcomere ultrastructure depends on salt concentration. Theses changes, which seem to begin by a solubilisation of the Z line, are probably due to the interaction between the increase of the ionic strength and the mincing effect. Important differences in preservation seen in the same preparation (micrographs F and G) suggests a heterogeneity in salt concentration in the muscle. Ripoche *et al.* (2001) observed that the sarcomeres and Z lines of sausage meat with 1.3% salt are totally destroyed. However, the preparation was based on pork muscle. These results indicate a different behaviour of myofibrils in the presence of salt depending on the muscle species used in the preparation.

Conclusion

A previous classification system of the extent of muscle alteration during processing of pork cannot be applied directly to beef treated by similar mincing and salt. Beef shows better preservation of myofibrils even with higher salt concentration.

References

Ripoche A., Le Guern L., Martin J.L., Taylor R.G. and Vendeuvre J.L. (2001). Sausage structure analysis. Journal of Food Science, 66, 670-674.

Offer G., Knight P. (1988). The structural basis of water holding in meat. In Developments in meat science, vol 4. Lawrie R, editor, pp 63-173. New York. Elsevier Applied Science.

Acknowledgements

This study was realised with the support of OFIVAL (French Interprofessional Meat, Breeding and Poultry Agency) and INTERBEV (French Interprofessional Cattle and Meat Association).