EARLY *POST-RIGOR* CLASSIFICATION OF BEEF MEAT ON LEVEL OF TENDERISATION

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INTRODUCTION

The rate of tenderisation of beef meat is especially slow and this causes economic problems due to its necessary storage, but what is even more problematic is the fact that this rate of tenderisation varies considerably among animals. Meat is usually sold within one week and at that time not all meat is fully aged. Therefore consumers do not get consistently aged meat and this is a cause of variation in tenderness which comes in addition with the variation associated with connective tissue. The reduction of the variation in tenderness associated with ageing is a first step for the commercialisation of meat with more consistent quality.

Different approaches can be investigated to produce more aged meat.

1 Fundamental studies (Dransfield 1992) on enzymatic phenomena involved in tenderisation will give the best conditions or technology which will accelerate tenderisation.

2 Selection of animals, with increased rate of tenderisation, may be possible because calpastatin activity is highly heritable (Shackelford *et al* 1994).

3 The control of the level of tenderisation of meat at an early time during storage should be investigated to classify meat. Different classes of level of tenderisation of meat could be directed toward different circuits of distribution. This will avoid long storage of already aged meat and also the commercialisation an unaged meat. The feasibility of this approach is the purpose of this study.

MATERIAL AND METHOD

This work used 45 heifers (mean age 36 months). Carcasses were conventionally chilled at an industrial slaughter house and were then stored at 3 ± 1°C. Slices (4 cm thick) were obtained from Longissimus dorsi, vacuum packed and frozen the day after slaughter (30 h *post-mortem*) and days 2, 4, 10 and 14. Freezing was in alcohol bath at - 20°C. These conditions of freezing give a time of freezing of about 5 min allowing minimum degradation of the structure by ice crystals (Bevilacqua *et al* 1979). Slices were then stored at -20°C. Before measurement slices were thawed in water bath at 10°C. The measurement of the resistance of muscle fibres was achieved on raw meat with the sinusoidal compressive method developed by Lepetit and Salé (1985). With this method, the resistance of muscle fibres is about 40 N/cm^2 when meat is in full rigor and 8 N/cm^2 in aged meat.

RESULTS

The evolution of the resistance of muscle fibres during storage shows huge variation among animals (fig 1). This confirms that, even when animal are selected on biological characteristics (young and female) which are known to have a positive influence on tenderisation, this does not solve the problem of variation in rate of tenderisation. Some muscles reached the limit value of 8 N/cm^2 within 2 days *post-mortem* whereas others did not reach this value until 14 days.

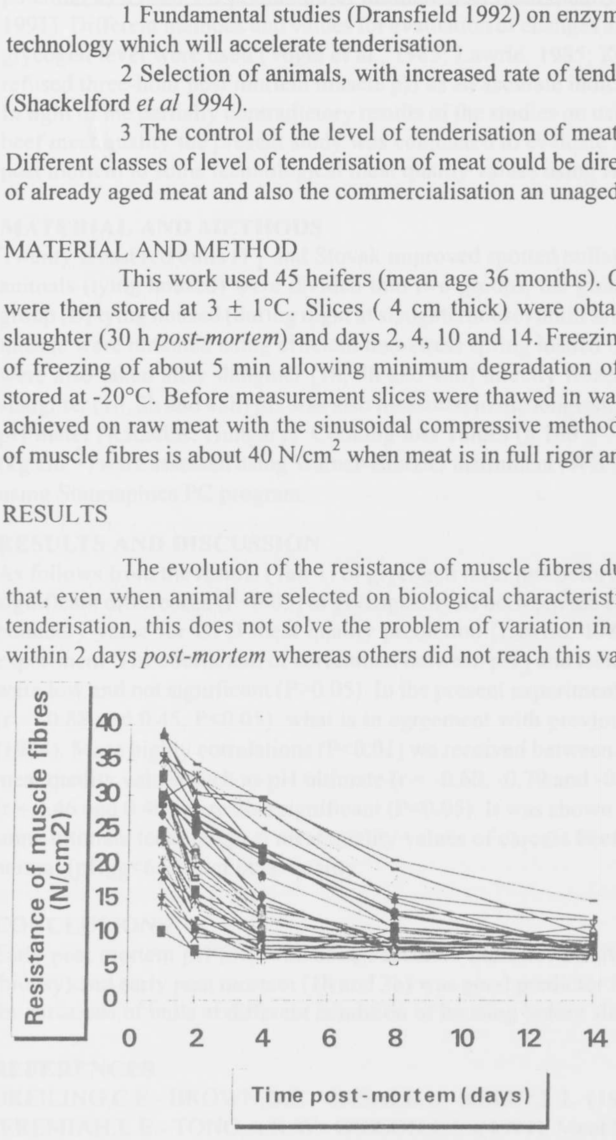

Figure 1 : Evolution during storage of the resistance of LD muscle fibres from 45 heifers.

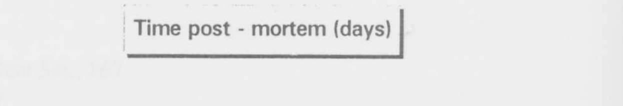

Figure 2 : Correlation coefficients between resistances measured at different times *post mortem*.
Each curve represents the correlation coefficients between the resistance, noted in legend, and the resistances measured at different times *post-mortem*, noted in the abscise.

To evaluate the usefulness of a measurement at a definite time *post-mortem* in predicting the resistance at a later time, we have correlated the resistances measured at different times. The resistance measured at days i (i= 1, 2, 4, 8) was correlated with the resistance measured at days k (k>i; k=2, 4, 8, 14). Two types of correlation were used : Pearson and Spearman. The latter is the correlation of rank and eliminates problems of non-linearity. The results with the 2 types of correlation are almost identical. Only Pearson correlations are represented (Fig 2).

A measurement made at day 1 (30 h *post-mortem*) can predict about 65% ($r^2 \sim 0.65$) of the variation observed at day 2 and day 4 and about 50 % of that observed at day 8. A measurement made at day 2 can predict about 80% of the variation observed at day 4 and 65 % of the variation observed at day 8, that is when meat has achieved about 92 % of the tenderisation between day 1 and day 14. These results show that there is a close correlation between successive values of resistance during ageing, or in other words there are not a lot of curves that cross one another. Therefore an early measurement can be used to predict the further evolution of a meat.

There is obviously a weaker link between the resistances measured at 2 times *post-mortem* when the period between the 2 times increases. But in this experiment we observed that the link between the resistances at day 1 and day 2, that is one day apart is 0.8 whereas the link between resistances at day 2 and day 4, that is 2 days apart is better (0.9). This can be due to the fact that at day 1 some LD muscles have not reached full rigor. For a muscle not in full rigor at day 1, a low resistance at day 1 will correspond to a high resistance at day 2 and this will decrease the correlation coefficient.

So, when the industrial conditions are such that some muscles are *pre-rigor* at day 1, it is better to make the predictive measurement only at day 2. The measurements made at day 2 can be used to define classes of meat according to their level of tenderisation. In these different classes, different percentages of meat will be aged at the same time *post-mortem*. To define the percentage of aged meat in each class we have grouped the mean values according to the test of Newman and Keuls. The aged meat was defined as those whose resistance was not significantly different from 8 N/cm^2.

Four levels of threshold have been applied to the values obtained at day 2 (20, 25, 30, 45 N/cm^2), which means, for example, in the first option (20 N/cm^2) that all the animals with resistance at day 2 lower than 20 N/cm^2 were retained. The percentage of animal retained in each case are respectively 52 %, 71%, 91%, and 100% of the original population. The percentage of aged meat in each case are represented in figure 3. A selection at day 2 of the muscles with value lower than 20 N/cm^2 will give 100% full aged meat at day 8 whereas only 70% of aged meat will be obtained if no threshold is applied.

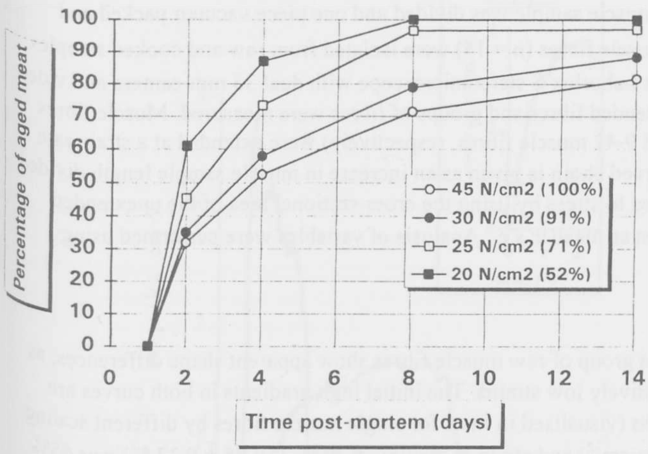

Figure 3 : Percentage of aged meat versus time of storage when selection of meat was made at day 2.
In the legend, for example 20 N/cm2 refers to a group of animals whose resistance at day 2 was lower than 20 N/cm2. The values in bracket represent the percentage of animals in the population.

CONCLUSIONS

The differences in the level of tenderisation observed during ageing among animals are evident just after rigor. Therefore a measurement of the resistance of muscle fibres in the first days *post-mortem* can be used to select meat which will be aged at a selected time of commercialisation. This would lead to a better control of storage cost and also a more consistent meat quality. In this experiment, the best time for measurement was day 2, but, depending on *pre-rigor* temperature storage and on the use of electrical stimulation, day 1 could be more appropriate.

REFERENCES

Dransfield E. 1992. Meat Sci., **31**, 85-94.
Shackelford S. D., Koohmaraie M., Cundiff L.V., Gregory K.E., Rohrer G.A., Sawell J.W. 1994. J. Ani. Sci., **72**, 857-863.
Bevilacqua A., Zaritvky N. E. , Calvelo A. 1979. J. Food Techno.,**14**, 237.
Lepetit J., Salé P. 1985. Sci. Aliments, **5**, 521-540.