# POST MORTEM CHANGES IN THE MECHANICAL PROPERTIES AND THE ULTRASTRUCTURE OF THE LONGISSIMUS OF LARGE WHITE AND PIETRAIN PIGS

MINELLI G.*, ASTRUC T. A., CULIOLI J.**, VIGNON X.** and MONIN G.**,*

* Istituto di Zootecnica, Universita degli Studi di Bologna, Bologna, Italy ** Station de Recherches sur la Viande, INRA, 63122 St Genes Champanelle, France.

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## SUMMARY

Eight Large Whites and 7 Pietrains were slaughtered. The pH was measured in the longissimus thoracis at 30 min after slaughter (pH1) and again after 26 h (pH2). The longissimus thoracis et lumborum was used for measurements of cooking loss, myofibrillar strength and elasticity (raw meat), mechanical resistance (cooked meat), sarcomere length (raw meat) and electron microscopy (raw meat).at days 1, 2, 3, 6 and 14 after slaughter. Breed affected significantly the pH1, the myofibrillar strength and the compression modulus in raw meat, and the mechanical resistance and the compression modulus in cooked meat. Ageing time affected significantly the mechanical resistance of cooked meat and the compression modulus of raw meat in Large Whites, and elasticity in Pietrains. There were close relationships between the pH1 value and mechanical traits in the raw meat. Ultrastructural changes were more marked in Large Whites than in Pietrains until day 6. It is concluded that the meat from Pietrains pigs is tougher than that from Large Whites pigs and that it tenderizes to a lesser extent during ageing.

## Introduction

In the European countries, most slaughter pigs are produced by crossing two or more breeds or composite lines. To predict the result of crossbreeding in terms of meat quality, it is needed to know the relevant characteristics of the breeds and the mode of inheritance of these characteristics. The Pietrain and Large White breeds are widely used for crossbreeding in many countries. Examination of the results of Dumont (1974) and Touraille and Monin (1982, 1984) indicates that the meat from the former is likely to be markedly tougher than the meat from the latter, although no direct comparison has been made to our knowledge. The present study was designed to verify this assumption and to investigate the kinetics of the post mortem changes in mechanical properties and ultrastructure of muscle tissue in the Large White and Pietrain breeds.

## Materials and methods

The experiment used 8 Large White pigs and 7 Pietrain pigs of about 100 kg liveweight, slaughtered in the city slaughterhouse of Clermont-Ferrand (France). Blood was taken at bleeding for DNA-testing of halothane sensitivity. The pH1 (30 min post mortem) and the pH2 (26 h) were measured in the longissimus thoracis at the level of the last rib. The left longissimus was excised and mechanical measurements, determination of sarcomere length and ultrastructural observations were carried out at days 1, 2, 3, 6 and 14 post mortem.

Sarcomere length was measured on raw samples by laser beam diffraction (Voyle 1971, Cross et al. 1980-81). Mechanical measurements were performed on raw and cooked samples. For cooking, 2.5 cm thick slices were vacuum-packed and cooked for 30 min at 75 ¡C, then cooled in a waterbath at 20 ¡C. Cooking loss was measured. The mechanical measurements were performed with the Food Texture Analysis System described by Sal_ et al. (1984) on strips of 3 x 1.0 x 1.0 cm. The strips were submitted to one sinusoidal compression cycle (0.1 s period). Raw and cooked strips were compressed up to compression ratios of 0.2 and 0.8, respectively. Three parameters were determined: the maximum stress reached during the compression cycle and the compression modulus in both raw and cooked meat, and the elasticity factor in raw meat. The maximum stress in raw meat has been shown to represent the mechanical resistance of the myofibres and will be referred to as myofibrillar strength (Lepetit et al., 1986).

Electron microscopy was performed at days 1, 6 and 14 after slaughter. Muscle blocks of 2-3 mm3 were fixed, dehydrated, embedded and cut in 70-80 nm thin sections, then stained with uranyl acetate and lead citrate. The observations were carried out using a microscope Philips EM 400 at an accelerating voltage of 80 kV.ResultsAccording to the DNA-test for HAL alleles, all Pietrains were nn, while 6 Large Whites were NN and 2 were Nn. The values of the various traits measured in raw meat are shown in Table 1. The myofibrillar strength and the compression modulus were markedly higher in Pietrains than in Large Whites ($P < 0.01$) which indicated a tougher meat in Pietrains. There was a significant breed x time interaction for the compression modulus ($P < 0.05$), which increased from 75 at day 6 to 108 at day 14 in Large Whites ($P < 0.05$) while it tended to decrease in Pietrains.

The values for cooked meat are given in Table 1. The maximum stress and the compression modulus were higher in Pietrains than in Large Whites. The maximum stress decreased with time. The relationships between pH1 values and mechanical parameters are illustrated in Table 2 and Fig. 1. In raw meat, there was close relationships between pH1 and both myofibrillar strength (all days) and compression modulus (from day 1 to day 6). No significant relationship was observed between pH1 and mechanical resistance in cooked meat. No significant relationship was found between pH2 and any mechanical parameter in both raw and cooked meat (results not shown).

The ultrastructural changes during ageing are illustrated in Fig. 2. Changes in the myofibrillar structure, such as weakening of Z-lines, were apparent from day 1 in muscle from both breeds. During storage, alterations of the Z-disks and loss of myofibrillar alignment occurred to a larger extent in muscle from Large Whites than from Pietrains. Fragmentation of myofibrils was observed in places. These changes were faster in Large Whites than in Pietrains between days 2 and 6. Breed difference was no longer observed at day 14.

## Discussion and conclusions

The breed differences in the mechanical resistance of fresh and cooked meat are likely to be related to the halothane-sensitivity status of the pigs. Touraille and Monin (1982) then Boles et al. (1991) reported that the meat of halothane-positive pigs was tougher than that of negative pigs. Other authors found that PSE meat, which is frequently associated with halothane sensitivity, is tougher than normal meat (Buchter and Zeuthen 1971, Bennett et al. 1973; Topel et al. 1976) and tenderizes to a lesser extent (Buchter and Zeuthen, 1971; Feldhusen and KŸhne 1992). However the association between toughness and PSE is controversial. Using instrumental measurements, Fox et al. (1980) found the PSE meat more tender, while Bennett et al. (1973) found it tougher than the normal meat; Deethardt et al. (1971) found no difference. By assessing meat quality with a sensory panel, Deethardt et al. (1971), Kemp et al. (1976) and Feldhusen and Kuhne (1992) found the PSE meat more tender than normal meat, while Fox et al. (1980) observed no difference. Clearly this point needs careful investigation. The slow rate of myofibrillar degradation in muscle from Pietrains confirms the previous observations of Estrade et al. (1991). The lack of tenderization with time in Pietrains agrees with the reports of Buchter and Zeuthen (1971) and Feldhusen and KŸhne (1992) that pork with a fast rate of post mortem pH fall tenderizes more slowly and to a lesser extent than normal meat. The mechanisms underlying the effects of halothane-sensitivity on meat toughness deserve investigation. In raw meat, it is likely that halothane-sensitivity acts mainly through its effect on the rate of pH fall. However this mechanism is probably of less importance for cooked meat, as shown by the lack of relationship between pH1 and mechanical traits. Halothane-sensitivity influences the post mortem localization of calcium in the muscle cells and it could therefore affect proteolysis by this way (Estrade et al. 1991).. In conclusion, the meat from Pietrains pigs appears to be tougher than that from Large Whites pigs. Moreover it tenderizes to a lesser extent during ageing. The results presented here indicate that this difference is at least partly explained by the halothane sensitivity status of these breeds. This has evidently some implications for pig production. As these breeds are widely used for crossbreeding, it would be of interest to establish the mode of inheritance of the halothane sensitivity effect on meat texture, and if the breed difference in meat texture is dependent also on a polygenic inheritance.AcknowledgementsThanks are expressed to A. Talmant (INRA) for technical assistance, B. Dominguez (INRA) for help in mechanical measurements, and to R. Klont (IVO, Zeist, The Netherlands) who performed the DNA-tests.

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