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POST MORTEM PROCESSES IN BREAST MUSCLE OF CHICKENS WITH DIFFERENT GROWTH RATES AND PROTEIN EFFICIENCIES.

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Introduction:

Growth of muscular tissue is the result of anabolic and catabolic processes which are counteracting, their equilibrium being regulated by the demand of the organism (Goldberg, 1969a,b). Changes in muscular mass, as a result of a changing demand by the organism, are caused by a coordinated change in the kinetics on both sides of the equilibrium. Relative changes on one or both sides of the equilibrium will result in an increased or decreased muscle growth (Bergen and Merkel,1991).

As there is a natural limit to the protein synthesis rate (Calzone *et al.,* 1983), one might argue that in extremely fast growing animals, net muscle accretion is mainly regulated on the catabolic side of the equilibrium.

The activity of endogenous proteolytic enzymes in muscle tissue is a major factor in the process of the conversion of muscle to meat called aging (Goll *et al.*, 1983, Koohmaraie *et al.*, 1991, Ouali, 1990, 1992). Not only tenderness, but also color and waterholding capacity and probably also taste, are partly determined by proteolytic processes in muscular tissue after slaughtering of the animal and during storage of the meat. The activity of endogenous proteinases is mainly determined by the intramuscular pH and temperature, and the amount of active proteinases and inhibitors present.

Schreurs et al. (1995) have shown that chickens selected for a very fast growth show a markedly decreased proteolytic capacity of both the calpains/calpastatin as well as some cathepsins/cystatins, compared to chickens growing extremely slow. Chickens with a very efficient protein metabolism showed intermediate calpain/calpastatin values, but increased cathepsin H and cystatin activities.

Purpose of the experiment described here was to investigate the *post mortem* changes in breast muscle of chickens from different lines selected for growth rate (GL-line) and protein efficiency (FC-line) and to compare these changes to those in chickens from an extremely slow growing and very protein-inefficient line (White Leghorn) and chickens of a normal commercial broiler type (Ross).

Materials and Methods

The eggs from four lines were hatched at the Spelderholt institute. The one-day-old chicks were sexed at the day of hatching and 10 males and females from all lines were housed separately in 4 replicate floor pens resulting in 40 birds per line per sex available at the day of slaughter.

At the day of slaughter, the birds were cooped and transported to the processing plant. They were electrically stunned in a waterbath at 100 V, and bled by neck cut for 90 seconds. The animals were neither scalded or plucked nor eviscerated. The breasts including bone were immediately removed in a such manner that the breast muscle was left completely intact. Measurements were carried out at 0, 1, 2, 6, 24 and 48 hours *post mortem*. After removal, the breasts were wrapped in plastic bags and kept in ice slush untill a temperature of 12°C was reached inside the breast muscle. Subsequently the breasts were stored at 12°C for a maximum period of 6 hours *post mortem*. After 6 hours samples to be processed 24 and 48 hours *post mortem* were transferred to 0°C. For measurements of pH, R-value and Myofibrillar fragmentation index (MFI) samples were taken from the inside of the muscle. Care was taken to avoid use of tissue that had been exposed to the surface.

pH measurements

Measurement of the pH was carried out according to Jeacocke (1977) on 4 birds of each line and sex.

R-value measurements

R-value measurements were carried out according to Honikel and Fischer (1977) on 4 birds of each line and sex.

Myofibrillar Fragmentation Index (MFI)

MFI measurements were carried out according to Olson *et al* (1976) on 4 birds of each line and sex.

Shear-force measurements

The breasts were heated in a steam cabinet at 0, 1, 2, 6, 24 and 48 hours *post mortem* untill a core temperature of 85°C was reached. The 0 time samples were not cooled. After heating the samples were stored at 0°C untill measurement which was carried out within 24 hours after heating. After deboning shear force measurements were done according to Froning and Uijttenboogaart (1988) on 5 birds of each line and sex.

Data analysis

Statistical analysis was carried out using SPSS/windows. Differences between lines and sexes at different times *post mortem* were analyzed with simple factorial ANOVA using the following model: $y_{ij} = s_i + l_j + (s*l)_{ij} + e$

where: s = sex (i = male, female)
l = genetic line (j = leghorn, FC, ross, GL)
e = experimental error

Results and Discussion

Statistical analysis did not show significant (p>.05) differences between the sexes so they were done on pooled male and female data. The first graph shows the intramuscular pH at different times *post mortem*. The only significant differences that could be established, occur at 24 and 48 hrs *post mortem*. The pH of the leghorns remains significantly higher (P<.001) than the muscle pH in the three broiler lines. The second graph shows the R-values at different times *post mortem*. This figure is an indicator for the status of ATP breakdown in the muscle. No significant differences between lines were detected. Both the pH and the R-value are a measure of the glycolytic status and hence the rigor-development of the muscle. These data may lead to the conclusion that *post mortem* glycolysis and thus the development of *rigor* mortis did not differ significantly between different chicken lines. The higher final pH of the leghorns is probably caused by lower initial glycogen stores in the breast muscle. Currently analyses of metabolites of the glycolysis are being carried out in our laboratory to investigate these processes in more detail.

The third graph shows the course of the myofibrillar fragmentation index (MFI) during the *post mortem* phase. This value is a very rough indicator of the proteolytic status of the muscular tissue. At death (t=0) and at 1 and 2 hrs *post mortem* no significant differences were detected. At 6 hrs *post mortem* the leghorns show a significantly higher myofibrillar fragmentation than the FC (p<.01) and GL-line birds (p<.05). No significant differences were detected at 24 and 48 hrs *post mortem*. It can be argued that the leghorns, due to their much larger proteolytic capacity (Schreurs *et al.*,1995) show a much quicker development of myofibrillar fragmentation than the other types. The lack of significant differences between the leghorns and the Ross birds at 6 hrs *post mortem* is probably caused by the large variability in the MFI data of the latter group. Since the MFI is a very rough indicator for proteolytic status, it is important to verify these data with more sensitive methods. Currently, in our laboratory, electrophoretic and immunochemical experiments are being carried out to investigate the *post mortem* proteolysis in more detail.

The last graph shows the course of the Warner Bratzler shear force measurements. Breast muscles of leghorns, and to a lesser extent, of FC-line birds are smaller and thinner than the Ross and GL-line birds, so a correction of shear force values was applied according to Frohning and Uijttenboogaart (1988) and the results were expressed as Newtons per millimeter tissue. It is clear that from 2 hrs *post mortem* on, the leghorns show significantly lower (p<.001) shear force values than the three broiler lines. The FC-line birds show lower (p<.001) values than the GL and Ross broilers from 6 hours *post mortem* on.

Figure 1: *pH in muscle*

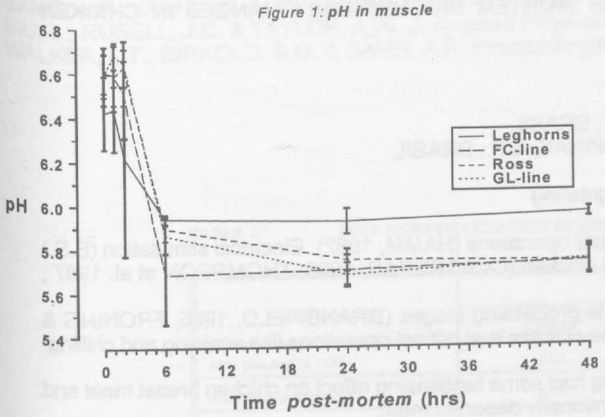


Figure 2: *R-value*

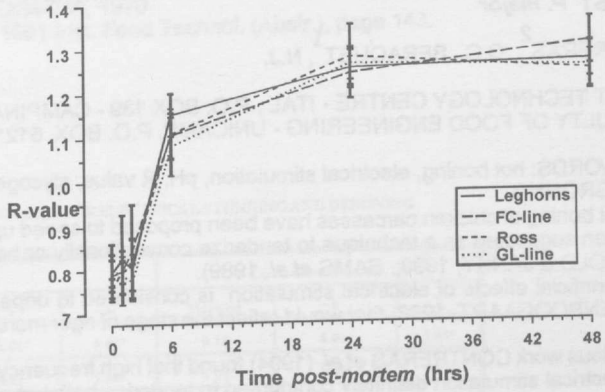


Figure 3: *Myofibrillar fragmentation index*

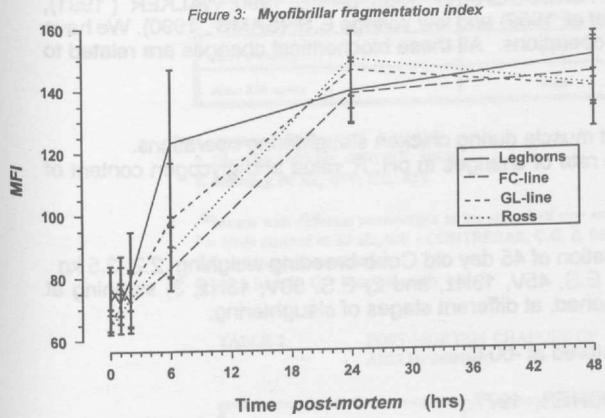
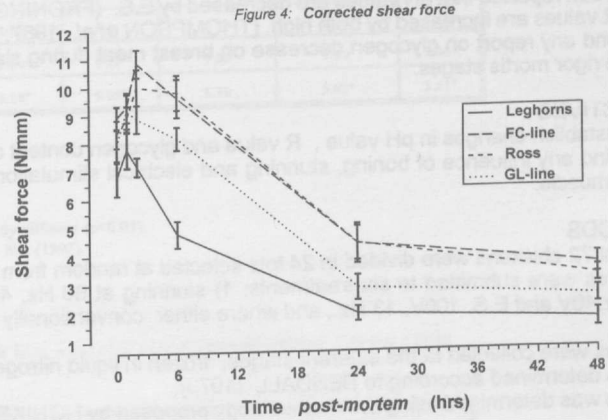


Figure 4: *Corrected shear force*



The GL and Ross birds did not differ significantly. These data agree with the results of Schreurs *et al.* (1995). The birds with the largest proteolytic potential show the fastest aging while the GL and Ross broilers, with a low proteolytic capacity, age slowest. The FC-line birds show intermediate aging rates. Although it is generaly accepted that aging in chicken breast muscle is complete after 48 hrs *post mortem*, these data indicate that in the fast growing and thus slow aging broilers these processes do not have to be completed 48 hours after slaughter.

In conclusion more extensive research is needed in order to generate more knowledge about the impact of genetic selection programmes on broiler meat quality.

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