

XIXth European Meeting of Meat Research Workers.Paris 2-7 Sept. 1973.Biochemical analyses of ante-mortem muscle samples.Relationships with meat quality in pigs.

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Introduction

Schmidt et al (1971, 1972) showed that the amount of Glucose-6-Phosphate analyzed in muscle biopsies taken ante mortem have some predictive value for the ultimate meat quality.

It was our aim to study the biopsy technique further. Therefore different kinds of experiments were made.

First of all within pigs samples were compared in regard of glucose-6-phosphate, ATP, CP and lactic acid. Secondly incubations effects on these substances were studied. Thirdly the muscle biopsy figures were used as a reference in a treadmill experiment.

Materials and methods

1. In 20 Dutch Landrace pigs approximately two weeks ante mortem two separate muscle biopsies were taken at the same site of the left and right m.long.dorsi. Analyses on G6P, ATP, CP and lactic acid were made according to Kastenschmidt et al (1968) respectively. The samples right and left were taken at random in following order

2. The influence of incubation on the sample was tested, because the possibility existed that the rate of glycolysis would be better pronounced. The expected higher variability of the metabolites might give a better correlation with the meat quality.

In three different comparisons the original time lapse of 2 minutes between biopsy sampling and analysing used in the method of Schmidt et al was compared against:

- a 10 minutes incubation at 38<sup>0</sup> C (11 DL pigs)
- a 10 minutes incubation at 15<sup>0</sup> C (15 DL pigs)
- a 10 minutes incubation at 38<sup>0</sup> C in a tissue culture medium TC Medium 199 Difco (10 DL pigs)

3. During 10 minutes or so much shorter as the pig became fatigued, 21 DL pigs were subjected to light exercise (5 km/h) on a treadmill. These pigs were biopsied immediately after the treatment. Twenty one control pigs underwent a biopsy in the pen.

### Results

1. In table 1 the comparison between the first and second m.long dorsi biopsy is given. This is an indication of the differences between right and left.

Table 1. Comparison within pigs between two biopsies of the m.long.dorsi (n = 20)

|                           | nr.1           | nr.2           | r(transmission value) |
|---------------------------|----------------|----------------|-----------------------|
| G6P $\mu\text{mol/g}$     | $2.2 \pm 0.9$  | $2.3 \pm 0.8$  | 0.64 P < 0.05         |
| ATP $\mu\text{mol/g}$     | $3.7 \pm 2.0$  | $3.1 \pm 1.8$  | -0.08 n.s.            |
| CP $\mu\text{mol/g}$      | $8.4 \pm 2.9$  | $7.6 \pm 2.4$  | -0.23 n.s.            |
| Lactate $\mu\text{mol/g}$ | $16.6 \pm 6.8$ | $17.4 \pm 5.2$ | 0.45 n.s.             |

No statistical differences could be detected between the two samples for all the analyzed substances.

The variances between the samples of different animals were higher than the variances between the samples of the same animal. For the first sample taken from each animal a correlation was calculated with the ultimate meat quality (transmission value). Only the G6P revealed a significant correlation (0.64).

### Conclusion

It was concluded that no differences exist between biopsies taken whether right or left from the m.long.dorsi.

2. The incubation results are expressed in table 2.



Table 2. The mean figures of the biopsy analyses after incubation at different periods temperatures and medium. (mean  $\pm$  50).

|                           | C              | a              | C              | b              |
|---------------------------|----------------|----------------|----------------|----------------|
| G6P $\mu\text{mol/g}$     | 2.9 $\pm$ 1.8  | 1.4 $\pm$ 0.8  | 3.0 $\pm$ 1.2  | 2.6 $\pm$ 1.9  |
| ATP $\mu\text{mol/g}$     | 4.5 $\pm$ 0.8  | 3.7 $\pm$ 1.3  | 5.0 $\pm$ 1.3  | 4.7 $\pm$ 1.3  |
| CP $\mu\text{mol/g}$      | 8.7 $\pm$ 1.9  | 8.0 $\pm$ 2.2  | 7.5 $\pm$ 2.3  | 7.4 $\pm$ 2.3  |
| Lactate $\mu\text{mol/g}$ | 11.8 $\pm$ 6.1 | 26.4 $\pm$ 1.7 | 11.7 $\pm$ 4.5 | 13.8 $\pm$ 6.6 |

  

|                           | C              | c              |
|---------------------------|----------------|----------------|
| G6P $\mu\text{mol/g}$     | 2.2 $\pm$ 1.0  | 1.0 $\pm$ 0.3  |
| ATP $\mu\text{mol/g}$     | 4.3 $\pm$ 1.2  | 2.7 $\pm$ 0.7  |
| CP $\mu\text{mol/g}$      | 6.4 $\pm$ 2.0  | 3.2 $\pm$ 1.7  |
| Lactate $\mu\text{mol/g}$ | 12.4 $\pm$ 6.7 | 15.7 $\pm$ 6.0 |

C = 2 minutes  $<$  20<sup>0</sup> C

a = 10 minutes 38<sup>0</sup> C

b = 10 minutes 15<sup>0</sup> C

c = 10 minutes 38<sup>0</sup> C-Medium TC 199

Comparisons within pigs indicated that only the lactate production increased substantially during incubation at 38<sup>0</sup> C (a).

As could be expected ATP and CP contents dropped. In contrast to lactate stood the G6P fall especially when incubation was made at a high temperature level.

The 10 minutes period at a lower 15<sup>0</sup> C level showed no important differences with the 2 minutes period of the control procedure.

### Conclusion 2

The conclusion seems to be warranted that for the G6P assay the original Schmidt procedure (1972) has to be preferred.

3. The experiment with two groups of 21 DL pigs in which one group was subjected to exercise the following data were collected (table 3).

Table 3. Treadmill exercise (18 minutes, 5 km/h) and its effect on the muscle metabolism of Dutch Landrace pigs (n = 21).

|                           | control        | experiment     |
|---------------------------|----------------|----------------|
| G6P $\mu\text{mol/g}$     | 3.2 $\pm$ 1.8  | 2.6 $\pm$ 1.2  |
| ATP $\mu\text{mol/g}$     | 3.9 $\pm$ 1.0  | 3.8 $\pm$ 1.1  |
| CP $\mu\text{mol/g}$      | 8.8 $\pm$ 3.0  | 9.1 $\pm$ 3.1  |
| Lactate $\mu\text{mol/g}$ | 16.6 $\pm$ 8.9 | 14.2 $\pm$ 5.4 |

There were no statistical significant differences between the groups. We got the impression that in stead of the expected higher content of glycolytic metabolites G6P and lactate tended to decline during exercise. One very fatigued pig showed very low figures for G6P (1.3  $\mu\text{mol/g}$ ), ATP (1.2  $\mu\text{mol/g}$ ), CP (0.5  $\mu\text{mol/g}$ ) and normal lactate (13.8  $\mu\text{mol/g}$ ). The correlations with the ultimate meat quality were significant in regard of the glycolytic metabolites for the control group (table 4).

Table 4. Correlations with the ultimate meat quality (transmission value and quality score) in 2 x 21 DL pigs.

|         | Transmission value |            | Quality score |            |
|---------|--------------------|------------|---------------|------------|
|         | control            | experiment | control       | experiment |
| G6P     | 0.56**             | -0.02      | 0.53**        | -0.12      |
| ATP     | 0.17               | -0.23      | 0.23          | -0.33·     |
| CP      | -0.04              | -0.14      | 0.05          | -0.20      |
| Lactate | 0.45*              | -0.21      | 0.44*         | 0.36·      |

\*\* P < 0.01

\* P < 0.05

· P < 0.10

### Conclusion 3

In comparison with the controls no effect of the treadmill exercise on the muscle metabolism could be detected. The fact that no correlation between the ultimate meat quality and the glycolytic metabolites existed suggests an interaction of the exercise.



### Discussion and overall conclusion

From the foregoing experiments it was concluded that it has no advantage to change the Schmidt biopsy procedure by way of incubation of the samples especially at a higher temperature (38<sup>0</sup> C).

Furthermore it was concluded that no difference in G6P and lactate content exists between two samples taken at the same time from the left and right m.long.dorsi. This provides the possibility to study effects on the muscle metabolism comparing biopsies before and after treatment. In a trial where animals were subjected to muscle exercise the data of the muscle samples revealed no effect on the glycolysis when compared with those of a control group.

The post mortem quality parameters showed only in the control groups a statistically significant relationship with the biopsy G6P and lactate of the glycolysis. From the figures of the different studies it was shown that the G6P content of the biopsy measured by the method of Schmidt gives the best correlation with the meat quality.

### Literature

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Summary

By way of the biopsy technique according to Schmidt et al (1972) muscle samples of Dutch Landrace pigs were collected some weeks before slaughter and analysed for Glucose 6-Phosphate, lactic acid, ATP and CP. Comparisons between samples were made within pigs, between incubations and between animal treatment (exercise).

Between samples taken at the same moment from the right and left m.long.dorsi no difference was shown within the pigs.

Incubations during several minutes under different conditions of the 200 mg sample lowered most of the levels of the analyzed substances except for lactate. Therefore the original procedure was preferred.

Exercise on a treadmill during 18 minutes did not change the level of the energy rich phosphates (ATP and CP) and the glycolytic metabolites (G6P and lactic acid).

The pre slaughter Glucose 6-Phosphate content gave the best indication for the post mortem meat quality of the m.long.dorsi.



ANALYSES BIOCHIMIQUES D'ECHANTILLONS DE MUSCLES  
ANTE-MORTEM ET LEUR RELATION AVEC LA QUALITE DE  
LA VIANDE DE PORC

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PAYS BAS

Résumé :

Au moyen de la technique de biopsie de Schmidt et col (1972), des échantillons de muscle de porcs Landrace hollandais ont été prélevés quelques semaines avant l'abattage ; on a dosé :

- glucose 6 - phosphate, acide lactique , ATP et créatine phosphate (CP)

et effectué des comparaisons entre porcs, entre incubations et entre traitements de l'animal (exercice).

Entre des échantillons prélevés au même moment, sur le côté droit et gauche du muscle longissimus dorsi, on ne trouva aucune différence entre les porcs.

Une incubation de plusieurs minutes dans un milieu physiologique de l'échantillon de 200 mg abaissait la plupart des teneurs en substances analysées ; cette technique fut abandonnée.

L'exercice sur un plan incliné pendant 18 minutes ne changeait pas le niveau de la teneur en phosphates à haute énergie (ATP et CP) et des métabolites glycolytiques (G 6P et acide lactique).

La teneur avant l'abattage en glucose 6 phosphate donnait la meilleure indication pour la qualité de la viande post mortem dans le muscle longissimus dorsi.

BIOCHEMISCHE ANALYSEN VON MUSKELPROBEN ANTE-MORTEM UND

IHRE BEZIEHUNG MIT DER FLEISCHBESCHAFFENHEIT BEIM SCHWEIN

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Niederlande

Zusammenfassung :

Mit Hilfe des Biopsieverfahrens nach Schmidt u. Mitarb. ( 1972 ) wurden Muskelproben von Schweinen der holländischen Landrasse einige Wochen vor dem Schlachten entnommen ; eine Bestimmung von Glucose 6 - Phosphat, Milchsäure, ATP und Kreatin - Phosphat ( KP ) wurde durchgeführt ; die Ergebnisse der verschiedenen Schweine, Brutmethoden und Tierhandlungen ( Übungen ) wurden verglichen.

Bei den verschiedenen Schweinen wurde kein Unterschied zwischen den aus der rechten und linken Seite des m. longissimus dorsi gleichzeitig entnommenen Proben festgestellt.

Eine Brutdauer von mehreren Minuten in einem physiologischen Medium der Probe von 200 mg führte zu einer Senkung der meisten analysierten Substanzgehalte ; diese Methode wurde nicht weitergeführt.

Die Übungen auf einer geneigten Fläche während 18 Minuten führte zu keiner Veränderung der Zahl der energiereichen Phosphate ( ATP und ITP ) und der glycolytischen Metabolite ( G-6-P und Milchsäure ) .

Der Glucose 6 - Phosphat - Gehalt vor dem Schlachten stellt das beste Merkmal der Fleischbeschaffenheit post mortem beim m. longissimus dorsi dar.