# GLYCOGEN CONCENTRATIONS AND ENZYME ACTIVITY LEVELS IN BICEPS FEMORIS MUSCLE DURING A FIVE DAYS PERIOD AFTER BIRTH IN NORMAL AND SPLAYLEG PIGS

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The occurrence of splayleg and splayweak pigs in a Swedish Landrace sow herd was described in a previous paper (Svendsen & Bengtsson, 1982), and the maternal, litter, and husbandry factors which may contribute to the disease were analysed and discussed. In this paper, will be presented some preliminary data on muscle and liver glycogen levels and on the activities of some of the oxidative and glycolytic muscle enzymes of pigs with signs of having splayleg or of being splayweak. Data on the unaffected, clinically normal pigs are included for purposes of comparison.

By the time of birth, normal pigs have developed very high muscle and liver glycogen levels. These rapidly decrease, and reach levels similar to those of adult pigs after one week of life (Hakkarainen, 1975). Disturbed activity of regulatory enzymes as well as disturbances in the carbohydrate metabolism have been discussed as factors involved in neonatal piglet deaths and in the occurrence of splayleg. The objects of the present study were to study from birth to 5 days of age the glycogen levels in muscle and liver, and the oxidative and glycolytic enzyme activity levels in the muscle of normal piglets and of splayleg and splayweak piglets.

All tissue samples were obtained from pigs produced by one pure breed Swedish Landrace sow herd, where splayleg pigs and splayweak pigs have been diagnosed consistently over a period of more than 4 years (Svendsen & Bengtsson, 1982). A total of 100 biopsies from the liver and M. biceps femoris (euthanized pigs) and from only M. biceps femoris (live, anesthesized pigs) were frozen in liquid nitrogen within 2 minutes of removal and were stored at -80°C until analysed. For analysis, the tissue was freeze dried and the muscle dissected free of connective tissue and blood. Glycogen was analysed according to Essén & Henriksson (1974). The activities of citrate synthase (CS) as a measure of citric acid cycle activity, triosephosphate dehydrogenase (TPDH) and lactate dehydrogenase (LDH) as a measure of glycolytic capacity, and 3-OH-acyl-CoA dehydrogenase (HAD) as a measure of lipid oxidation were determined at 25°C using fluorimetric techniques according to Essén et al. (1980).

The results for the unaffected pigs are presented in Table 1.

Glycogen: In clinically normal piglets, the glycogen levels were very high throughout the first 24 h after birth, in both the biceps femoris (mean 1971±357 mmol x $kg^{-1}$) and the liver (mean 1603±670 mmol x $kg^{-1}$). The biceps levels were approximately 5 times as high as that of adult swine. From the first to the second day after birth, a dramatic decrease in the glycogen levels of the muscle and the liver (36 and 56 per cent, respectively), was observed. The levels of muscle glycogen continued to decrease and on day 5 was 674±114 mmol x $kg^{-1}$, which approximated that of adult pigs (Table 1).

Glycolytic enzymes: The activity levels of LDH and TPDH at birth were only about 5 per cent those of the adult pig. During the 5 days after birth, these levels increased, until on day 5 they were one quarter of the adult levels.

Oxidative enzymes: The activities of CS and HAD were rather high already at birth being about half the levels of that of the adult. The CS activity increased to adult levels by 5 days of age whilst the HAD activities only increased slightly.

TABLE 1: Glycogen concentrations (mmolxkg$^{-1}$) and enzyme activities (μmol/g/min) of triosephosphate dehydrogenase (TPDH), lactate dehydrogenase (LDH), citrate syntase (CS), 3-OH-acyl-CoA dehydrogenase (HAD), in biceps muscles of apparently normal pigs during the neonatal period and of adult pigs

| No of pigs | Age (hrs) | Glycogen x̄±S.D. | TPDH x̄±S.D. | LDH x̄±S.D. | CS x̄±S.D. | HAD x̄±S.D. |
|---|---|---|---|---|---|---|
| 6 | 0-3 | 2009±236 | 144±43 | 96±49 | 11.5±1.6 | 8.4±2.0 |
| 8 | 4-6 | 2207±295 | 263±95 | 91±49 | 14.1±3.4 | 9.9±2.1 |
| 5 | 7-12 | 1803±373 | 180±92 | 121±40 | 12.3±1.8 | 11.1±2.0 |
| 6 | 13-24 | 1751±400 | 226±81 | 120±89 | 14.4±3.7 | 9.8±1.0 |
| 5 | 25-36 | 1234±210 | 157±81 | 79±60 | 17.7±3.2 | 11.6±2.4 |
| 5 | 37-48 | 1288±310 | 327±85 | 187±83 | 16.7±3.4 | 8.5±4.0 |
| 6 | 49-72 | 885±234 | 297±145 | 200±121 | 18.6±6.6 | 10.4±4.0 |
| 6 | 73-96 | 747±133 | 524±60 | 377±157 | 21.8±2.9 | 9.8±2.8 |
| 4 | 97-120 | 674±114 | 516±283 | 454±73 | 23.7±3.0 | 12.2±2.2 |
| Adults (mean) | | 400 | 2500 | 1800 | 20 | 24 |

TABLE 2: Glycogen concentrations (mmolxkg$^{-1}$) and enzyme activities (μmol/g/min) of TPDH, LDH, CS and HAD in biceps femoris muscle of unaffected, splayleg and splayweak pigs

| | | Unaffected | | Splayleg | | Splayweak | |
|---|---|---|---|---|---|---|---|
| Age (h) | | 0-24 | 25-48 | 0-24 | 25-48 | 0-24 | 25-48 |
| No. pigs | | 25 | 10 | 8 | 6 | 7 | 6 |
| Glycogen | x̄ | 1971 | 1261 | 1897 | 1408 | 2098 | 1102 |
| | S.D. | ±357 | ±251 | ±573 | ±771 | ±453 | ±718 |
| TPDH | x̄ | 209 | 242 | 184 | 200 | 160 | 189 |
| | S.D. | ±90 | ±118 | ±77 | ±91 | ±87 | ±68 |
| LDH | x̄ | 105 | 133 | 118 | 94 | 93 | 123 |
| | S.D. | ±57 | ±89 | ±66 | ±51 | ±23 | ±41 |
| CS | x̄ | 13.2 | 17.2 | 11.0 | 15.8 | 12.9 | 17.8 |
| | S.D. | ±3.0 | ±3.2 | ±2.6 | ±5.5 | ±4.3 | ±7.3 |
| HAD | x̄ | 9.8 | 10.1 | 7.1 | 7.9 | 7.3 | 12.0 |
| | S.D. | ±1.9 | ±3.5 | ±2.6 | ±1.7 | ±3.0 | ±4.7 |

For the splayleg and splayweak pigs, less than 48 h old, the level of liver and muscle glycogen, and the glycolytic and oxidative enzyme activity levels in the muscle were similar to clinically normal piglets. No significant differences were observed (Table 2), although the values of the glycolytic enzymes were slightly lower in the splayleg and splayweak pigs. Extremely low glycogen levels were found in some cases which corresponded to the clinical observations of starvation in these pigs.

During the first 5 days of life, the physical activity of the pig greatly increases, and in addition it almost doubles its bodyweight. Correspondingly, the demand for energy increases. Glycogen appears to be one of the main sources of energy for the newborn pig. Similar to many other investigations, a constant and dramatic decrease in the glycogen levels in both the muscle and the liver was observed, although the acticity levels of the glycolytic enzymes remained relatively low. The different responses of the glycolytic and oxidative enzymes, as shown by their activity levels, during the crucial first days of the life of the pig may indicate that the regulation of these enzymes differ. Thus the high activity levels at birth of the oxidative enzymes and the rapid activity increase may partly be explained by the type and amount of physical activity performed during the first days. In addition there is an increased need for enzymatic activities during the neonatal period because of the rapid cell growth. As a consequence the regulatory oxidative and glycolytic muscle enzyme activities also increase.

It is concluded that the splayleg and splayweak pigs showed similar glycogen depletion pattern and similar pattern of increase in glycolytic and oxidative enzyme activities as found in unaffected pigs during the first days of life.

References: Essén, B. & Henriksson, J.: Acta physiol. scand., 1974, 90:645-647. Essén, B., Lindholm, A. and Thornton, J.: Equine vet. J., 1980, 12:175-180. Hakkarainen, J.: Acta Vet. Scand. Suppl., 1975, 59:1-198. Svendsen, J. & Bengtsson, A-C.: Proceedings, IPVS, Mexico, 1982.