Histological characteristics of different muscles of pigs influenced by dietary levels of lysine

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SUMMARY: The purpose of this research was to studythe influence of two levels of dietary lysine on histological characteristics of two different muscles in pigs. Forty pigs YorkshirexHampshire (barrow and sow) were randomly allotted to two dietary lysine levels and slaughtered at approximately 95 kg. Samples for histological evaluation were obtained from the longissimus thoracis (LT) and the trapezius. Muscle samples were evaluated for fiber type using enzyme substrates to demonstrate presence of aerobic (βR) and anaerobic (αW) fibers. OIL-RED-O was used to detect the presence of intramuscular fat cells. The sows had significantly larger αR fibers in LT muscle, while the trapezius showed in the barrows smaller βR and αW fibers ($P \leq .05$). Statistical significance for percentage of αW and αR fiber type in LT ($P \leq .05$) between the sexes.

INTRODUCTION: The effect of nutrition on the histological characteristics of muscle in pigs is very important, Feeding swine different levels of amino acids to produce faster growth rates and more lean tissue needs more study in order to determine the correct level of amino acid even though many reports in the literature including Southern et Baker (1982); Anderson et al. (1894); Lin F.D. et al. (1986); M. S. Edmonds et al. (1987); Nicastro and Zezza (1988) have already dealt with this.

Edmonds and Baker (1985) reported linear depression in weight gain and feed intake as increments of lysine. Meat production is based on type and size of the muscle fibers as well as their metabolic characteristics. Considerable differences in fibre composition can occur in the various muscles of one and the same animal.

The objectives of our study were to study the effects of two levels of dietary lysine on histological properties of longissimus thoracis and trapezius (pars thoracica) muscles.

MATERIALS and METHODS: Forty pigs Yorkshire x Hampshire were allotted in equal number (barrow and sow) to two feeding regimes of dietary lysine [.65 (A) and .95 (B)]. The diets consisted of corn and soybean meal supplemented with minerals and vitamins (NRC, 1988). The two lysine levels were obtained by altering the relative proportion of corn and soybean meal in the diet. Pigs were allowed to consume feed and water ad libitum and were placed on test at an average weight of 25 kg. At approximately 95 kg the pigs were stunned electrically, exsanguinated, dehaired and eviscerated. The carcasses were chilled at 3° C for 24 h, after evaluated, measured and cut into wholesale cuts. Samples for histological studies were obtained from the center of the longissimus thoracis (Kauffman et at. 1990), of the left side at the 10th rib and from the trapezius (pars thoracica) muscles. Duplicate samples were immersed into liquid nitrogen. The frozen muscle samples were mounted on a cryostat chuck and allow to equilibrate at -20° C. Serial sections were mounted on glass microscope slides and thenstained with NADH-Tr (Engel and Brook, 1966), myofibrillar ATP-ase reacted at alkaline pH (Guth et al. 1970; Nicastro 1988) and OIL - Red - O and Hematoxylin (Lillie, 1965). Once the tissue section was stained, the slides were observed with a Photomicroscope and several fields on each section sta ined were photographed. Enlarged photomicrographs were used to analyze and differentiate intramuscular fat cells and muscle cell types. Muscle cells were typed on the basis of staining reaction into Red (βR), Intermediate (αR) and white (αW) types (Ashmore et al. 1972). All fibers inside a field size were counted and then measured using a Zeiss Image Analyzer. In addition to fiber diameter and area, the percent of cells for each of the three types was calculated. Data were analyzed by least-squares analysis of variance (SAS, 1985), assuming a mathematical model that included the fixed effects of lysine level and the sex. Differences among means were tested for significance using the protected least significant difference procedure (Steel and Torrie, 1980).

RESULTS and DISCUSSION: The results of longissimus thoracis muscle are presented in tables 1 and 2. Addition

of lysine to the basal diet resulted in a size increase of fiber type except for the white fiber, this in accord with previous results (Nicastro and Zezza, 1988). For the βR fibers the differences were significant ($P \leq .05$). Between the sexes, the sows had fibers larger with significance for that αR. Lysine diet and sex affected fat cell area ($P \leq .05$), they were larger in diet B and in barrows. The percentage of the βR and White fibers ($P \leq .01$) followed same trend of area. These data support the idea that fiber differentiation, accompanies physiological maturity, and at 100 kg approximately the barrows were closer than sows to physiological maturity.

Least squares means for size and population of muscle fibers in the trapezius are presented in table 2. For comparing the two levels of lysine the larger fibers (alpha-Red and alpha-White) were noted in swines fed diet A, but the differences were not significant. Sex source influencved the area of the βRed ($P \leq .05$) and White fiber ($P \leq .01$), and the sows with larger area in the fiber type. The percentage of fibers in trapezius muscle affected neither the diet nor sex, since the actual difference was small. An increase in lysine level, as used in this study, on other hand, did not appear to have a consistent effect on fiber size, while the fat cell area generally increased with level of lysine and followed an inverse pattern in the two muscles between the sexes.

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Table 1 - Least squares means for area (μm^2) of fibers and fat cells in longissimus thoracis muscle

	Fibers			Fat
DIET	βRed	αRed	α White	cells
A	1357.1 a	2172.6	2942.9	1981.1 a
B	2252.0 b	2414.2	2605.2	2812.9 b
SEX				
Barrow	1667.4	1969.4 a	2788.6	2956.5 a
Sow	1941.7	2617.3 b	2759.4	1837.6 b

a,b ($P \leq .05$)

Table 2 - Least squares means for percentage of area fibers in longissimus thoracis muscle

	Fibers		
DIET	βRed	αRed	α White
A	19.9 A	34.3	45.8 A
B	29.5 B	33.6	36.9 B
SEX			
Barrow	24.1	30.0 a	45.9 A
Sow	26.3	35.5 b	38.2 B

A,B ($P \leq .01$)

a,b ($P \leq .05$)

Table 3 - Least squares means for area (μm^2) of fibers and fat cells in trapezius muscle

	Fibers			Fat
DIET	βRed	αRed	α White	cells
A	2412.4	2553.4	2720.3	2052.1
B	2875.0	2400.2	2439.8	2153.2
SEX				
Barrow	2171.7 a	2169.5	2060.4 A	1993.6
Sow	3115.7 b	2784.1	3099.6 B	2211.7

A,B ($P \leq .01$)

a,b ($P \leq .05$)

Table 4 - Least squares means for percentage of area fibers in trapezius muscle

	Fibers		
DIET	βRed	αRed	α White
A	31.2	35.4	33.4
B	35.7	31.8	32.5
SEX			
Barrow	34.0	32.1	33.9
Sow	33.0	35.1	31.9