SEX AND COMPUDOSE® IMPLANTATION EFFECTS ON PORCINE LONGISSIMUS AND SEMIMEMBRANOSUS FIBRE TYPES

M.C. HUNT, G.A. HIGHFILL, M.E. DIKEMAN AND R.H. HINES,
Department of Animal Sciences and Industry, Kansas State University, Manhattan, KS 66506-USA

INTRODUCTION

Early research (Needham 1926) established that muscle is composed of a heterogeneous mixture of red and white fibres. The role of these fibre types in animal growth and development (Ashmore et al. 1972; Johnston et al. 1981) and in various postmortem changes (Cassens 1977; Young and Foote 1984)) is not totally clear. Fibre-type populations appear to be determined primarily by muscle function (Needham 1926) and innervation (Swatland and Cassens 1973), but the effects of other factors, such as time of fibre type formation, domestication, level of nutrition, proximity of blood circulation, and hormonal effects, are not well established (Ashmore 1974; Rahelic and Puac 1981; Solomon et al. 1981; Young 1984). Data for the bovine (Holmes and Ashmore 1972; Dreyer et al. 1977; Young and Bass 1984) and the ovine (Moody et al. 1980) suggest that part of the variation in percentage of muscle fibre-type is attributable to sex. However, there were no significant differences in fibre populations in porcine muscle for barrows and gilts (Miller et al. 1975) and in feral fallow deer (Field and Young 1985).

The purpose of this study was to characterize the effects of sex and Compudose® implantation on muscle fibre type and size in porcine longissimus and semimembranosus muscle.

EXPERIMENTAL METHODS

Boars, barrows, and gilts of 14 litters were allotted to six groups: 1) boars, 2) boars implanted with Compudose® (24 mg estradiol controlled release implant), 3) barrows, 4) gilts, 5) boars penned with a postpubertal gilt (BG), and 6) boars implanted with Compudose® and penned with a postpubertal gilt (IBG). Animals in groups 1 through 4 were littermates, whereas some animals in groups 5 and 6 were from different litters. Implants were administered and postpubertal gilts were placed in pens when the average animal weight per group was 45.4 kg. Animals were fed ad libitum and slaughtered at an average pen weight of 109 kg.

Muscle samples were collected 24 h postmortem. Longissimus (LD) muscles were removed between the 10th-12th thoracic vertebrae, and histochemical samples were taken from the centre of each muscle. Semimembranosus (SMB) samples were removed from the muscle's longitudinal centre, about 2.5 cm deep from the medial edge. Samples 1 cm^3 were removed, frozen in liquid nitrogen and stored at -80°C. Frozen sections (10 mm) were incubated for acid and alkaline myosin ATPase activity by the method of Guth and Samaha (1970). Preincubation of ATPase sections at 32°C was according to Suzuki and Cassens (1980), although the optimum pH's were slightly lower. Sections also were stained for NADH-TR activity (Engel and Brooke 1966).

Between 500 to 800 fibres per muscle were classified according to Suzuki and Cassens (1980 1983) as type I (acid ATPase, positive; alkaline negative), type II (acid ATPase negative; alkaline positive), SM (acid ATPase positive; alkaline moderate), SS (acid ATPase positive; alkaline positive) or MS (acid ATPase moderate; alkaline positive). Type II fibres were subdivided into Type IIA (NADH-TR positive) and Type IIB (NADH-TR negative). NADH-TR stained fibres were classified as red (including intermediate staining fibres) or white (NADH negative). Fibres were counted, and diameters were measured using a Zeiss TGZ-3 Particle Size Analyzer. Data were analyzed by analysis of variance and Least Significant Difference techniques.

RESULTS

The percentage of type IIB fibres (78.6 vs 73.3%) was higher ($P < 0.05$) and the percentage of type IIA (9.5 vs. 13.3%) was lower ($P < 0.05$) in the LD muscle than in the SMB. No differences ($P < 0.05$) were found between muscles for either type I (LD = 10.9, SMB = 12.0%) or MS, SS, and SM fibres (each <0.7%).

TABLE 1. LONGISSIMUS MUSCLE FIBER CHARACTERISTICS FOR SEX TREATMENTS

Fiber type	Treatment group: Boars n=9	Implanted boars n=8	Barrows n=6	Gilts n=6	BG[a] n=6	IBG[a] n=5
	Fiber type percentage					
ATPase						
IIB	78.1^{b}	78.0^{c}	79.3^{bc}	81.3^{b}	76.6^{c}	79.2^{b}
IIA	7.9	11.7	9.1	7.8	12.4	7.8
MS	.3	.4	.3	.3	.2	.2
SS	.4	.5	.4	.4	.5	.6
SM	.7	.6	.3	.6	.9	.5
I	12.9	9.3	11.3	10.1	9.7	11.9
NADH-TR						
Red fibers	29.3	26.0	31.8	28.7	29.2	34.8
	Mean fiber diameter, µm					
ATPase						
IIB	70.1^{d}	63.1^{b}	66.0^{bcd}	64.0^{bc}	70.9^{cd}	69.9^{cd}
IIA	54.7^{bc}	45.5^{bc}	50.3^{cd}	46.6^{bcd}	52.2^{b}	52.7^{d}
MS	39.8	41.0	48.6	41.2	37.1	51.8
SS	48.5	41.5	39.4	39.9	44.3	47.8
SM	40.6	36.0	31.6	35.9	42.8	40.7
I	58.9	57.8	59.5	54.0	58.2	59.2
Average	67.7^{c}	60.5^{b}	64.0^{bc}	61.6^{b}	67.1^{c}	67.1^{c}

[a] Boars (BG) and implanted boars (IBG) penned with a cycling gilt.

[bcd] Means in a row with a different superscript letter are different (P<.05).

Implanted boars and the BG group had a higher ($P < 0.05$) percentage of type IIA fibres in the LD muscle than boars, gilts and IBG group (table 1). No differences (P.05) were found between sex groups for any of the other ATPase and NADH-TR fibre types in the LD muscle.

Type IIA fibre diameters were larger ($P < 0.05$) in the LD muscle of boars, BG and IBG than implanted boars (table 1). Boars had larger ($P < 0.05$) type IIA fibre diameters than gilts. Diameters of MS type fibres in the LD were larger ($P < 0.05$) for the IBG group than for the boar, implanted boar, and BG groups. MS type fibres in the LD of barrows had larger ($P < 0.05$) diameters than those of the BG group.

Percentages of all fibre types in the SMB muscle did not differ ($P > 0.05$) across treatment groups (table 2). Type IIB fibre diameters were larger ($P < 0.05$) in the IBG group than in boars, implanted boars, barrows, and gilts, whereas type IIB fibre diameters were larger ($P < 0.05$) for the BG group than for implanted boars and gilts. Diameters of the type IIA fibres in the SMB were larger ($P < 0.05$) for the IBG group than for boars, implanted boars, and gilts. Type IIA fibre diameters also were larger ($P < 0.05$) in the BG group than in gilts. SMB type I fibres were larger ($P < 0.05$) in the BG and IBG groups than in boars, implanted boars, and barrows. Fibre diameters of types MS, SS, and SM fibres were not different ($P > 0.05$) for treatment groups.

When each fibre type was expressed as its percentage-area of the total fibre percentage-area, no differences were found between sex groups for either the LD or SMB muscles.

Since there were few and inconsistent differences in fibre percentages between treatment groups when fibres were classified into six ATPase fibre types, fibres were recategorized into three types, using two different nomenclature systems. When fibres were categorized as types I, II (A + B), and intermediate (SM + SS + MS), no differences in fibre percentages were found across treatment groups for either muscle. When fibres were categorized as types I, IIB, and intermediate (IIA + SM + SS + MS, all NADH-TR positive and ATPase alkaline positive), the only difference for fibre percentages occurred in the LD muscle where the BG group had more ($P < .05$) intermediate fibres (17.4%) than all other groups (8.2 to 12.8%), and the implanted boars had more intermediate fibres (12.8%) than the IBG group (8.2%). No difference in fibre populations were found between groups for the SMB muscle using the latter classification system.

TABLE 2. SEMIMEMBRANOSUS MUSCLE FIBER CHARACTERISTICS FOR SEX TREATMENTS

Fiber type	Boars n=11	Implanted boars n=10	Barrows n=9	Gilts n=5	BG[a] n=6	IBG[a] n=5
			Treatment group			
		Fiber type percentage				
ATPase						
IIB	74.4	76.0	72.5	73.1	70.1	71.2
IIA	14.4	11.3	14.1	15.2	15.0	13.9
MS	.1	.4	.3	.2	.2	.3
SS	.5	.4	.3	.4	.4	.6
SM	.7	.5	.4	.6	1.2	.9
I	10.3	12.0	12.9	11.0	13.4	13.4
NADH-TR						
Red fibers	39.2	40.1	38.7	43.2	43.8	40.4
		Mean fiber diameter, μm				
ATPase						
IIB	65.0^{bc}	60.8^{b}	64.1^{bc}	59.8^{b}	69.1^{cd}	71.8^{d}
IIA	50.6^{bc}	49.9^{bc}	51.2^{bcd}	48.0^{b}	54.4^{cd}	56.3^{d}
MS	51.3	41.9	44.7	41.2	37.1	54.7
SS	46.5	43.8	46.7	39.9	52.9	48.9
SM	45.2	43.6	38.8	32.1	49.2	49.5
I	49.4^{b}	50.2^{b}	50.9^{b}	52.5^{bc}	55.8^{c}	56.3^{c}
Average	61.3^{ab}	58.4^{a}	60.7^{ab}	60.8^{ab}	65.0^{bc}	67.4^{c}

[a]Boars (BG) and implanted boars (IBG) penned with a cycling gilt.

[bcd]Means in a row with a different superscript letter are different ($P < .05$).

DISCUSSION

Boars, barrows, and gilts in this study had growth, carcass, and hormonal differences indicative of their respective sex groups. In general, treatment group effects on fibre-type percentage and fibre diameters were small and inconsistent for both the LD and SMB muscles. This agrees with Miller et al. (1975), who found that fibre-type percentages were not different for barrows and gilts. Also, Field and Young (1985) reported no differences in fibre types of the splenius muscles of deer, even at the time of peak testosterone production. However, in the bovine (West 1974; Dreyer et al. 1977; Young and Bass 1984), the ovine (Moody et al. 1980), and mice (Vaughn et al. 1974), sex did alter some fibre-type percentages and fibre diameters.

MacDonald and Slen (1959) reported that estradiol administered to either ewes or wethers caused a significant increase in LD fibre diameter. Miller et al. (1975) reported that gilts had larger red and intermediate fibres than barrows. Our fibre diameter data were similar to those of Staun (1963), but no consistent pattern of sex effects on fibre diameter was found between gilts, boars, and barrows.

SUMMARY AND CONCLUSIONS

The primary objective of our study was to relate sex and Compudose® implantation of boars to muscle fibre-type characteristics. Even though significant differences between muscles for some fibre traits were demonstrated, no definitive trends within muscles were found across treatment groups for the fibre-type characteristics measured. Thus, we conclude that sex and Compudose® implantation of boars have little effect on fibre-type composition of porcine LD and SMB muscles.

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