EFFECT OF DIET ON GROWTH AND MUSCLE FIBRE CHARACTERISTICS OF BROILERS SLAUGHTERED AT SIX AND SEVEN WEEKS

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SUMMARY

An experiment was conducted to evaluate overall growth and muscle fibre characteristics of broilers (Hubbard & Hubbard) fed three different grain based diets (corn, barley and barley plus beta glucanase) and slaughtered at two ages (six and seven weeks). Histochemical procedures were used to characterize fibre types in the *pectoralis* and *semimembranosus* muscles. Broilers fed the barley-based diets gained less body weight than those fed the corn-based diet. The white (αW) fibres of the *pectoralis* muscle were larger in the older birds (seven weeks) and in those broilers fed the barley-based diets. Conversely, the red fibres (βR) of the *semimembranosus* muscle were largest in the seven week broilers fed the corn-based diet.

INTRODUCTION

Skeletal muscle comprises approximately fifty percent of the total body weight in the chicken (McNally and Spicknall 1949 a,b). Ashmore and Doerr (1971) observed three histochemical fibre types in chicken muscle based on the myosin ATPase activity of the muscle. It is well documented that tonic (slow) and phasic (fast) muscles differ from each other enzymatically, ultrastructurally and biochemically (Ali et al. 1986), and Moody et al. (1980) reported that a physiological shift from intermediate (αR) to white (αW) fibres occurred in muscle of lambs fed different rations. Other authors have shown that the type of muscle as well as the location within a given muscle may affect fibre characteristics.

Relatively few studies have been reported on the effect of diet and age on broiler muscle fibre characteristics. Since the ratio of oxidative to glycolytic fibre types within a muscle is associated with the composition and organoleptic traits of meat, it was felt that a study of this type would add valuable information toward better understanding of the basic properties of poultry meat.

EXPERIMENTAL METHODS

Male and female chicks (Hubbard and Hubbard) 1 day of age were divided equally into three diet treatment groups consisting of feeding a series of starter, grower and finishing diets based on 1) corn, 2) barley, or 3) barley + beta-glucanase. Beta-glucanase was still added to the barley-based diet to provide 20 enzyme units per kg diet. The barley-based diets were lower in metabolizable energy content than the corn-based diets. Feed and water were available ad libitum. Half of the birds from each treatment group was slaughtered at six and half at seven weeks. Following the plucking and evisceration process, carcasses were weighed and chilled at 3°C for approximately 24 hours. Samples for histological evaluation were obtained from the breast (*pectoralis*) and thigh (*semimembranosus*) muscles. Sampling of the *pectoralis* was done in such a way that only the white portion of muscle was removed. Duplicate muscle samples were immediately immersed in liquid nitrogen, mounted on a cryostat chuck, equilibrated to -20°C and then sectioned 16 m using a freezing microtome. Sections were mounted on glass slides and allowed to air dry then reacted with NADH-TR (Engel and Brooke 1966) and alkaline myofibrillar ATPase (Guth et al. 1970). Glycerol jelly was used to fix the cover slips in place. Each slide was observed with a Zeiss Photomicroscope and several fields from each serial section were photographed at 25x using the bright field setting. A stage micrometer (.01 mm) was photographed with each roll of film. Enlarged photomicrographs (12.7 x 17.8 cm) were used as the basis for characterizing muscle fibre types. Fibres in the *semimembranosus* were typed on the basis of their histochemical reaction and classified as red (βR)

Table 1. MEAN FIBER DIAMETER IN SEMIMEMBRANOSUS MUSCLE (μM)

	Fiber type					
	Beta-Red		Alpha-Red		Alpha-White	
	Age					
Diet	6 wks	7 wks	6 wks	7 wks	6 wks	7 wks
Corn	41.8^{A}	48.7^{B}	42.8	45.0	40.8^{A}	48.2^{B}
Barley	44.8	41.9^{A}	41.4	43.7	43.2	45.0
Barley + B-Gluc.	45.8	43.5	44.3	40.0	42.1	43.6
	Sex					
Male	43.0	43.7	44.4	42.3	43.1	44.6
Female	45.3	45.6	41.3	43.5	40.0^{A}	46.5^{B}

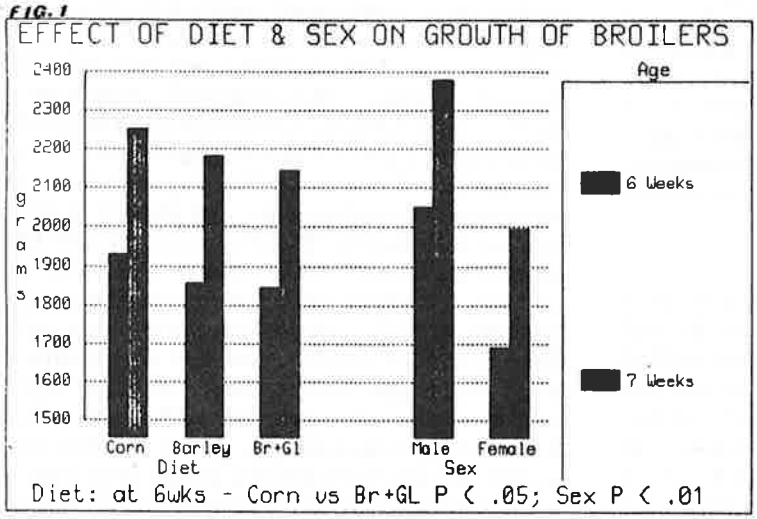
^{A,B} Means in columns and in rows within fiber types with different superscripts are different ($P < 0.05$).

Table 2. MEAN FIBER DIAMETER IN PECTORALIS MUSCLE[1] (µm)

Diet	Age 6 wks.	7 wks.	X
Corn	43.6^{A}	49.2^{C,D}	47.8^{A}
Barley	40.8^{BE}	53.9^{CF}	47.4^{AB}
Barley+B-Gluc.	41.9^{AB}	46.6^{D}	44.2^{B}
X	43.0^{E}	49.9^{F}	

[1] Predominantly Alpha-White Fibers
Means in columns with different superscripts are different: ^{A,B} $p < 0.05$; ^{C,D} $p < 0.01$.
Means in rows with different superscripts are different: ^{E,F} $p < 0.01$.

FIG. 1



intermediate (αR) and White (αW) as described by Ashmore and Doerr (1971). The *pectoralis*, as expected upon histochemical evaluation, contained all white fibre types (αW). This finding agrees with that of Gauthier and Lowey (1977).

All fibres inside a designated area (4 cm x 6 cm) were counted and subsequently measured using a Zeiss Particle Size Analyzer. Data were analyzed by least squares procedure (Harvey 1960). Differences among means were tested for significance using the protected least significant differences procedure of Steel and Torrie (1980).

RESULTS AND DISCUSSION

Table 1 shows the diameter of the three fibre types, βR, aR and aW in the *semimembranosus* muscle. The seven week broilers fed the corn-based diet had larger ($P < 0.05$) βR and aW fibres than birds fed the same diet for only six weeks. Also, the seven week-old broilers fed corn had larger ($P < 0.05$) βR fibres than the seven week broilers fed barley. No other significant differences existed in fibre type diameter either between age groups or among diet treatment comparisons. However the females had larger ($P < 0.05$) αW fibres across treatment groups than the males. Table 2 illustrates the variation in *pectoralis* aW fibre diameter among dietary treatments and between age groups. The six week-old broilers fed the corn based diet had larger fibre diameters than broilers fed the barley or barley plus beta glucanase ($P < 0.05$). However, in the seven week-old birds, fibre diameters were larger ($P < 0.01$) from broilers fed straight barley alone compared to either barley plus enzyme or corn. These data agree with Kiessling (1977) who found that growth continued up through 70 days. When comparing birds of different ages at slaughter, the seven week-old broilers in every case tended to have larger fibre diameters than their counterparts at six weeks. However, only in birds fed barley alone was this difference significant ($P < 0.001$).

The effect of dietary treatments on body weight is shown in figure 1. At six weeks, broilers fed the corn-based diet were significantly ($P < 0.05$) heavier than comparable birds fed barley plus beta glucanase. At seven weeks the trend was the same, except the weights of birds fed the various diets were not significantly different among groups. Research by Rotter et al. (1987) and Marquardt et al. (1987) demonstrated that the addition of enzymes to the diet of young chicks fed barley improved weight gains. The results of this experiment did not confirm these findings, probably because of the variation in the level of beta-glucans of barley from different varieties and growing conditions (Lyons, 1987).

CONCLUSION

The addition of the enzyme, beta-glucanase, to barley based poultry diets did not improve broiler growth nor alter fibre population in the *semimembranosus* muscle. Broilers fed the corn-based diet gained more than those fed the barley-based diets and had larger fibre diameters at seven weeks compared to other treatments.

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