

## A Comparative Histomorphometrical Study of *Quadriceps Femoris* Muscle Fibers Between Commercial Broiler and Domestic Fowls

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**Abstract:** In order to find out the histomorphometrical differences of muscle fibers of *Quadriceps femoris* between commercial broiler and domestic fowls, 40 birds (20 each species) from both sexes, aged 8 weeks, were used. Tissue samples were taken from the middle parts of left and right *Quadriceps femoris* muscle. After fixation in 10% buffered formalin solution, sections were prepared, using routine histological techniques. Tissue samples were stained by Hematoxylin and eosin. By using ocular micrometer, the mean diameters of the muscle fiber were measured. Also, the total numbers of muscle fibers were determined by using the lattice line graticule (5\*5). Results showed that the domestic fowls had more muscle fiber percentage than the Ross broilers. The histomorphometrical features of muscle fibers were similar in the left and right sides of *Quadriceps femoris* muscle in both chicken genotypes. No significant sex-based differences were found. It is concluded that the species-specific differences in muscle mass are primarily due to differences in the diameters and total number of muscle fibers.

**Key words:** Histomorphometry • Broiler • Muscle fiber • Domestic fowl • *Quadriceps femoris*

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### INTRODUCTION

Fast-growing chicken strains have shown much higher muscularity and pronounced hypertrophy [1] as compared with laying or slow growing chickens [2]. The major component of a muscle is the constituent muscle fibers. Species-specific differences in muscle mass are primarily due to differences in the number of muscle fibers. Muscle mass is therefore largely determined by the number of muscle fibers and the size of those fibers [3].

In Shahrekord, most of the farmers rear Ross industrial broiler and domestic fowls. These two chickens' strains reared in different conditions. The commercial broilers reared in well hygienic condition, in contrast, the domestic fowls are scavenger in nature fed by grains, seeds, green grasses and garden leftover [4]. In spite of scattered histological investigations on intramuscular connective tissues differences between dark and light

colored muscles by Mobini [4, 5], in broiler chickens, no comparative information is yet available on the numbers and diameters of the muscle fibers of *Quadriceps femoris* in the Ross commercial broilers and domestic fowls. Therefore, the present study was aimed to find out the differences of total numbers and diameters of the muscle fibers of *Quadriceps femoris* between these two chicken strains in both sexes.

### MATERIALS AND METHODS

A total of 40 adult clinically healthy chickens (aged 8 weeks), 20 from domestic fowls and 20 from Ross commercial broilers of both sexes (20 each sex) were obtained from the Research farm of household bird's maintenance of College of Veterinary Medicine, Islamic Azad University of Shahrekord. The domestic fowls were fed by grains, seeds, green grasses and garden leftover, in contrast, the commercial Ross broilers were reared in

well hygienic condition and received feed and water ad libitum. The birds were deeply anesthetized by excess ether inhalation. Tissue samples were taken from the middle parts of left and right *Quadiceps femoris* muscle. The samples were immediately fixed in 10% buffered neutral formalin solution for 24-48 hours, dehydrated and embedded in paraffin blocks. Tissue sections (5  $\mu$ m) were stained by Hematoxylin and eosin [6]. The total numbers of muscle fibers per  $\text{mm}^2$  were determined by using the lattice line graticule (5\*5) and the mean diameters of the muscle fiber were measured by using ocular micrometer. Data were analyzed by one-way ANOVA, using the SPSS statistic software version 18. Duncan's multiple range test was also used to detect significant differences ( $P < 0.05$ ).

## RESULTS

The total numbers of muscle fibers per  $\text{mm}^2$  of *Quadiceps femoris* muscle are shown in Table 1. The numbers of muscle fibers per  $\text{mm}^2$  of *Quadiceps femoris* muscle were more in the both sexes of the domestic fowls than those of the Ross broilers (Table 1).

Sex related differences were not observed for the total number of muscle fibers per  $\text{mm}^2$  of *Quadiceps femoris* muscle of both chicken strains. The minimum muscle fiber number in right side of *Quadiceps femoris* muscle was recorded in female Ross broilers ( $P < 0.05$ ). Although the minimum muscle fiber number in left side of *Quadiceps femoris* muscle was found in male Ross broilers, but the difference was not significant ( $P > 0.05$ ). The mean muscle fiber percentage in various sides of *Quadiceps femoris* muscle in domestic fowls varied between 73.3–81.3 and in Ross broilers: between 60–69.3 (Table 1).

No evident difference between the left and right sides of *Quadiceps femoris* muscle was observed in the histomorphometrical features of muscle fibers in both chicken strains (Tables 1, 2).

Sex related differences were not also observed for the mean muscle fiber diameters of *Quadiceps femoris* muscle of both domestic fowls and Ross broilers (Table 2).

The lowest muscle fiber diameter in left side of *Quadiceps femoris* muscle was found in female Ross broilers ( $P < 0.05$ ). The diameters of muscle fibers in right side of *Quadiceps femoris* muscle showed no significant differences between two chickens' genotypes ( $P < 0.05$ ). The mean muscle fiber diameters in domestic fowls ranged from 34.5–51.5  $\mu$ m, whereas in Ross broilers ranged from 37–45  $\mu$ m (Table 2).

Table 1: Average numbers of muscle fibers per  $\text{mm}^2$  (%) in different regions of *Quadiceps femoris* muscle in adult domestic fowls and Ross broilers (Mean  $\pm$  SE).

Strains	Gender	Right	Left
domestic fowl	Male	77.3 $\pm$ 6.1 <sup>b</sup>	76.0 $\pm$ 14.4
	Female	81.3 $\pm$ 2.3 <sup>b</sup>	73.3 $\pm$ 6.1
Ross broiler	Male	66.7 $\pm$ 9.2 <sup>ab</sup>	64.0 $\pm$ 10.6
	Female	60.0 $\pm$ 10.6 <sup>a</sup>	69.3 $\pm$ 14.0

Non-similar small letters within a column differ significantly ( $P < 0.05$ ).

Table 2: Average diameters ( $\mu$ m) of muscle fibers in different regions of *Quadiceps femoris* muscle in adult domestic fowls and Ross broiler (Mean  $\pm$  SE).

Strains	Gender	Right	Left
domestic fowl	Male	45.0 $\pm$ 6.4	51.5 $\pm$ 10.9 <sup>b</sup>
	Female	34.5 $\pm$ 8.4	42.5 $\pm$ 12.4 <sup>ab</sup>
Ross broiler	Male	42.5 $\pm$ 6.4	43.0 $\pm$ 4.8 <sup>ab</sup>
	Female	45.0 $\pm$ 10.3	37.0 $\pm$ 4.5 <sup>a</sup>

Non-similar small letters within a column differ significantly ( $P < 0.05$ ).

## DISCUSSION

The results revealed that histomorphometrical features of muscle fibers were similar in the left and right sides of *Quadiceps femoris* muscle in both chicken genotypes which is in agreement with the results reported by Mobini [4-5].

Sex-related differences in the number of muscle fibers have been reported for rats [7-8], cattle [9], chickens [10-11] and humans [12-13]. In these cases males exhibited higher muscle fiber numbers compared to females. But in the present study, sex related differences were not observed for the total number of muscle fibers per  $\text{mm}^2$  of *Quadiceps femoris* muscle of both chicken strains. Also no differences were found between male and female rat Soleus muscles [14], several mouse muscles [15-17] dog *Pectineus* muscle [18], pig *Longissimus* muscle [19-22] and human *Vastus lateralis* muscle [23-24]. Studies undertaken by Tobin and Joubert [25] revealed that the sex difference in muscle fibre number of rat *Levator ani* muscle is under the control of testosterone during the perinatal period. Testosterone treatment in later postnatal periods is able to increase muscle growth in a direct or indirect manner [26-27] by stimulating satellite cell proliferation and muscle protein synthesis [7, 28-29]. Additionally, differences in fiber number have been related to different physical activity between male and female muscles [12].

The domestic fowls had more muscle fiber percentage in *Quadriceps femoris* muscle than the Ross broilers in the present study. These differences might be due to the differences between the breeds [30].

In the present study, the mean muscle fiber diameters in domestic fowls ranged from 34.5–51.5  $\mu\text{m}$ , whereas in Ross broilers ranged from 37–45  $\mu\text{m}$ . The mean muscle fiber diameters range of various skeletal muscles among different the species were from about 20 to 80  $\mu\text{m}$  [3]. Muscle fiber diameters in two muscles of the laboratory mouse and rat were 20-41 and 39-64  $\mu\text{m}$  respectively [8, 16-17, 31-32].

No marked differences in muscle fiber diameter of *Quadriceps femoris* muscle were found between different chicken strains which is similar to previous findings [19, 33].

In conclusion, the domestic fowls had more muscle fiber percentage than the Ross broilers. The histomorphometrical features of muscle fibers were similar in the left and right sides of *Quadriceps femoris* muscle in both chicken genotypes. Sex related differences were not observed for the all histomorphometrical features of muscle fibers. Species-specific differences in muscle mass are primarily due to differences in the diameters and total number of muscle fibers.

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