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Age related muscle texture variation between Cobb-500 and Ross broiler strain

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Abstract

Meat characteristics of Cobb-500 and Ross boiler strains in terms of histomorphometry of myocyte, fat tissue and connective tissue were studied. Two representative muscles from breast (Pectoralis thoracis and Supracoracoideus) and two from thigh (Iliotibialis lateralis and Iliotibialis cranialis) were selected. Thicker myofiber in breast and thinner myofiber in thigh were found in Ross strain. The perimysial thickness significantly differed among the muscles. The perimysial thickness of breast and thigh muscle at 28th day and thigh muscle at 35th day of Cob-500 were found higher that indicate more toughness of representative muscles. Thick and broad bundles of collagen fiber were observed in perimysium of Iliotibialis lateralis and thinner but broad bundles were in perimysium of Pectoralis thoracis muscle. At 35th day of age the endomysial thickness was found same in both strains but at 28th day of age it was higher in Cobb-500 than that of Ross strain. The intramuscular fat deposited mainly within perimysium as cluster and the number (per focus) and the size of adipocyte diameter was differed among the muscles. Adipocytes diameter was recorded highest ($24.14 \pm 1.33 \mu$) in pectoralis thoracis muscle of Ross boiler and $22.01 \pm 1.74 \mu$ second in position in Cobb-500. The lowest diameter $15.62 \pm 0.87 \mu$ was recorded in case of Iliotibialis lateralis muscle of Ross boiler.

Keywords: Age, Strain, Meat characteristics, Broiler

Introduction

There is lack of sufficient animal protein in developing countries like Bangladesh due to population explosion. Poor people can hardly manage the standard daily requirement of protein. To fulfill this shortage commercial boiler can play an important role. Still boiler is the cheapest meat source in Bangladesh and it contributes 30% to the total animal protein for human consumption (Huque, 1996). Small scale commercial boiler farms are gradually rising due to their production yield in shortest period of time and low investment. Different strains of commercial boiler are reared in Bangladesh. Texture is the most important factor in determining meat quality of boiler from consumer's point of view (Dransfield *et al.* 1999). Meat texture depends on structures and composition of skeletal muscle, which is mainly, consists of muscle fibers and surrounding intramuscular connective tissue and fat deposition (Nishimura, 1999). But no sufficient research took place till now in Bangladesh regarding comparative study of meat characteristics among different boiler strain. So, the present research has been carried out to investigate age related muscle texture variation between Cobb-500 and Ross broiler strain.

Materials and Methods

A total 288 boilers, meaning 144 Cobb-500 and 144 Ross from 16 small scale farms were taken as biological sample. All the birds were fed with locally available feed (Kazi feed). The birds were slaughtered manually with the help of sharp knife, through ventral neck cutting. Following skinning & removal of subcutaneous fat, two representative muscles of breast (Pectoralis thoracis and Supracoracoideus) and two from thigh (Iliotibialis lateralis and Iliotibialis cranialis) were selected. About 1 cm of each muscle (3 mm in thickness) was preserved in 10% formalin for histological study. Same procedure was followed at 28th and 35th day of age. The tissue samples were dehydrated in ascending grade of alcohol, cleared in xylene, infiltrated and finally embedded in Paraffin. The sections are cut at 6 μ thickness and stained with hematoxyline and eosin (H & E) stain for general histological study. Perimysial and endomysial thickness, thickness of individual muscle fiber and adipocyte diameter were measured in 5 random microscopic focuses in each slide with the help of calibrated ocular micrometer. One small unit of calibrated ocular micrometer had the value of 14.5 μ when the tissues were observed under 10 objectives and 8 eyepiece. The raw data were recorded, entered and sorted using the MS excel. The data were calculated by one sample t-test and then transferred to analytical software SPSS (Version 11.5) for analysis. Initially the data were stored and cross checked for duplication and /or missing value. The missing values for each variable were recorded (numeric) as to be excluded in the analysis.

Result and Discussion

Structure of Muscle bundle

Group of muscle fibers surrounded by connective tissue layer, perimysium forming muscle fascicles was studied. Within the muscle fascicles the myocyte thickness was measured (Table 2). At 35 days of age the myocyte of pectoralis thoracis of Ross strain was thicker ($26.98\pm1.42\mu$) than that of Cobb-500 strain ($25.56\pm1.74\mu$) and this result was in agreement with Radu-Rusu et al., (2008) but in thigh region, myocyte of iliobibialis lateralis muscle of Cobb-500 was thicker ($24.14\pm1.74\mu$) than that of Ross broiler ($23.43\pm1.42\mu$). At 28 days of age the muscle fiber of pectoralis thoracis of Ross broiler was thicker ($24.85\pm1.59\mu$) than that of Cobb-500 ($24.14\pm1.74\mu$) and in iliobibialis lateralis of Ross broiler was thinner ($22.01\pm0.71\mu$) in comparison to that of Cobb-500 broiler strain ($22.72\pm0.87\mu$) (Table 2) and this result was in agreement with Radu-Rusu et al., (2008).

The individual muscle fibers were surrounded by a layer of delicate collagen and reticular fibers called endomysium (Plate 3). The endomysial thickness and interfiber gap was varied from muscle to muscle (Table 1). In the present study the individual muscle fiber of iliobibialis lateralis of the thigh at 28th day of age was more compact than the pectoralis thoracis of the breast muscles. At 35th day of age the endomyseal thickness was found same in both strains but at the day of 28 it was higher in Cobb-500 than that of Ross strain.

Table 1. Perimyseal and Endomyseal thickness (Mean \pm SEM) of two selected muscles at 28th and 35th days old of Cobb-500 and Ross broiler strains (n=5)

Parameters	Cobb-500		Ross	
	Perimyseal thickness (μ)	Endomyseal thickness (μ)	Perimyseal thickness (μ)	Endomyseal thickness (μ)
Day-28				
Pectoralis thoracis	63.90 ± 3.18	9.94 ± 1.33	62.48 ± 2.66	9.23 ± 1.42
Iliotibialis lateralis	62.48 ± 3.48	9.23 ± 1.42	61.06 ± 2.84	8.52 ± 0.87
Day-35				
Pectoralis thoracis	76.68 ± 7.24	11.36 ± 1.74	79.52 ± 7.24	11.36 ± 1.74
Iliotibialis lateralis	65.32 ± 3.49	11.36 ± 1.33	62.48 ± 3.48	11.36 ± 1.33

Mean \pm SE within a raw are statistically significant ($P<0.01$)

SE= Standard error

Table 2. Adipocyte and Myocyte thickness (Mean \pm SEM) of two selected muscles of 28th and 35th days old of Cobb-500 and Ross broiler strains (n=5)

Parameters	Cobb-500		Ross	
	Myocyte thickness (μ)	Adipocyte thickness (μ)	Myocyte thickness (μ)	Adipocyte thickness (μ)
Day-28				
Pectoralis thoracis	24.14 ± 1.74	19.88 ± 1.42	24.85 ± 1.59	19.17 ± 0.87
Iliotibialis lateralis	22.72 ± 0.87	17.04 ± 1.33	22.01 ± 0.71	15.62 ± 0.87
Day-35				
Pectoralis thoracis	25.56 ± 1.74	22.01 ± 1.74	26.98 ± 1.42	24.14 ± 1.33
Iliotibialis lateralis	24.14 ± 1.74	19.17 ± 1.42	23.43 ± 1.42	19.88 ± 1.42

Mean \pm SE within a raw are statistically significant ($P<0.01$)

SE= Standard error

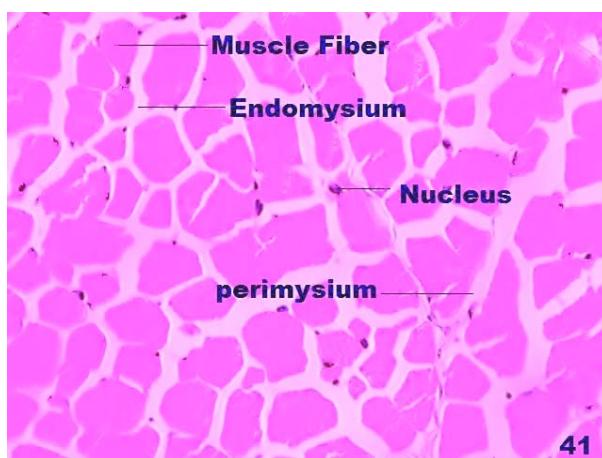
Connective tissue content

Entire muscle was surrounded by dense connective tissue called epimysium. The muscle bundle were surrounded by loose connective tissue chiefly consists of bundles of collagen fibers called perimysium. In the present study the perimysium thickness was significantly ($P<0.01$) differed among the muscles between the Cobb-500 and Ross strain (Table 1). Highest perimysial thickness ($79.52\pm7.24\ \mu$) at 35 days of age was observed in case of pectoralis thoracis muscle of Ross strain which was $76.68\pm7.24\ \mu$ in case of Cobb-500 (Table 1). Among breast muscles the perimysial thickness of pectoralis thoracis of Ross was thicker ($79.52\pm7.24\ \mu$) than that of Cobb-500 strain ($76.68\pm7.24\ \mu$) of 35th day of age but the perimysial thickness of iliobibialis lateralis of Cobb-500 was higher ($65.32\pm3.49\ \mu$) than that of Ross strain ($62.48\pm3.48\ \mu$) (Table 1). The same perimysial thickness ($62.48\pm2.66\ \mu$) was recorded in pectoralis thoracis of Ross and iliobibialis lateralis ($62.48\pm3.48\ \mu$) of Cobb-500 strain at 28th days of age. On the other hand more branched perimysium was observed in case of iliobibialis lateralis muscle. This result was in agreement to that of Nakamura et al., (2004) who recorded higher connective tissue content in thigh muscle than that of breast muscle.

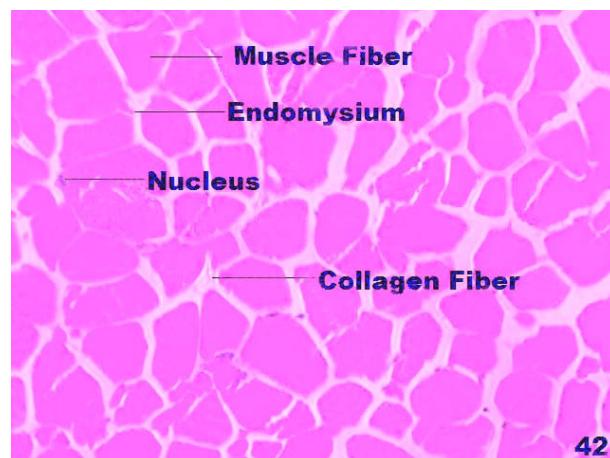
The perimysial thickness was directly related with its collagen fiber content. Thick and broad bundles of collagen fiber were observed in the perimysium of iliobibialis lateralis muscle (Plate 1), thinner but broad bundles were in the perimysium of pectoralis thoracis muscle (Plate 2). This result was in agreement with the report of Nakamura et al., 2003. However, the toughness of the muscle is largely depending on the perimysial thickness. So, the iliobibialis lateralis muscles are tougher among the other muscles of the present study because of their thick and broad endomyseal and perimysial collagen fibers. So the present study indicates that perimysial thickness has a close relationship to the meat toughness and toughness increase with the increase of perimysial thickness. This conclusion is in agreement with the result of Fang et al., 1999. They showed that the toughness of various skeletal muscles of pig significantly correlated with the thickness of perimysium and thickness of perimysium is one of the major factors that determine toughness of pork. A similar finding was also reported in case of chicken skeletal muscles by Liu et al., 1996.

Intramuscular fat deposition

The intramuscular fat was deposited mainly within the perimysium as cluster of adipocytes (Plate 4). The size of adipocytes deposited, varied among the muscles in the present study (Table 2). Adipocytes diameter was recorded highest ($24.14\pm1.33\ \mu$) in pectoralis thoracis muscle of Ross broiler and $22.01\pm1.74\ \mu$ second in position in Cobb-500. The lowest diameter $15.62\pm0.87\ \mu$ was recorded in case of iliobibialis lateralis muscle of Ross broiler.



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Plate 1. Cross sections of pectoralis thoracis muscle of Cobb-500 (41) and Ross (42) broiler strains showing perimysium, endomysium, muscle fiber and nucleus at 28th day of age. (H & E stain, 40x)

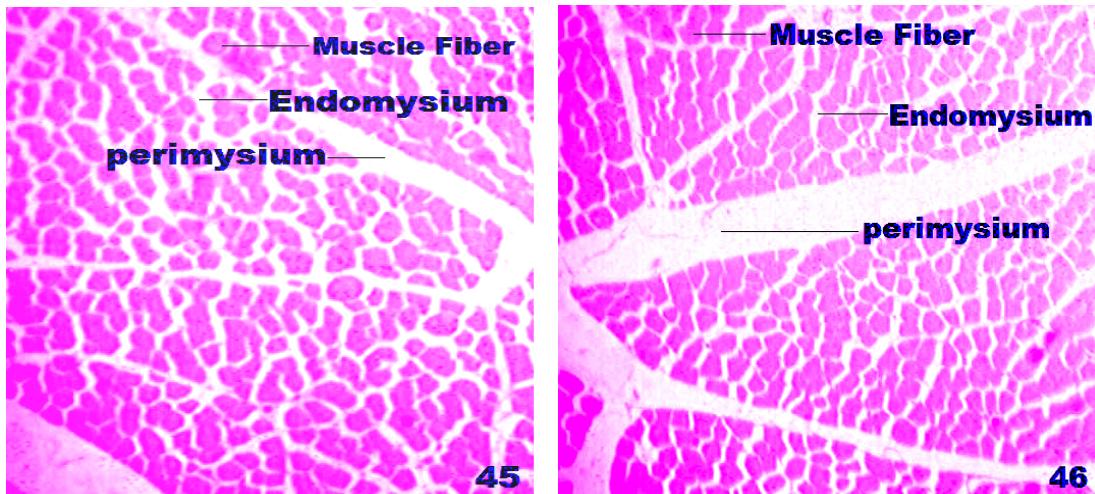


Plate 2. Cross sections of iliotibialis lateralis muscle of Cobb-500 (45) and Ross (46) broiler strains showing perimysium, endomysium and muscle fiber at 28th day of age. (H & E stain, 10x)

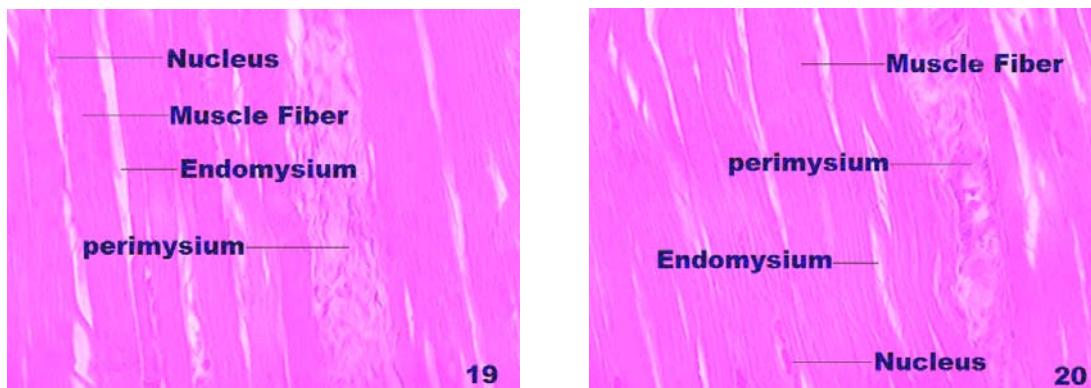


Plate 3. Longitudinal sections of iliotibialis lateralis muscle of Cobb-500 (19) and Ross (20) broiler strains showing endomysium, perimysium, muscle fiber and nucleus at 35th day of age. (H & E stain, 40x)

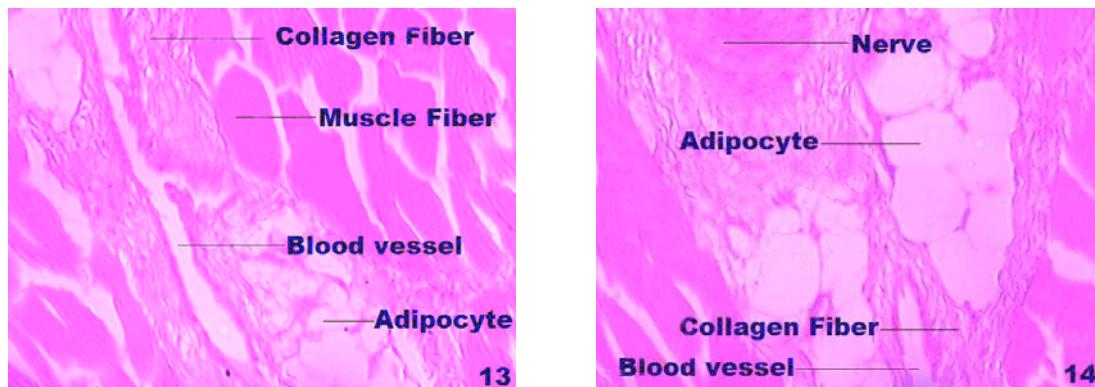


Plate 4. Longitudinal sections of iliotibialis lateralis muscle of Cobb-500 (13) and Ross (14) broiler strains showing collagen fibers, blood vessel, nerve, adipocytes and muscle fiber at 35th day of age. (H & E stain, 40x)

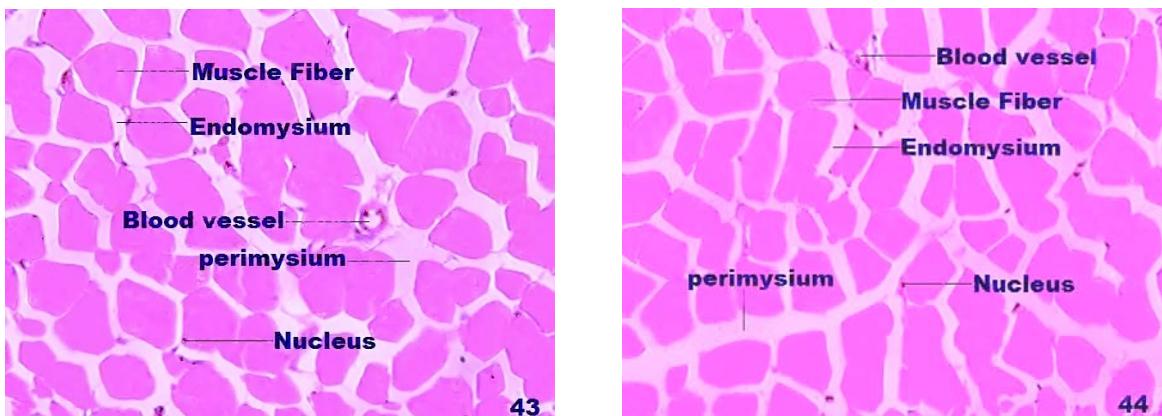


Plate 5. Cross sections of pectoralis thoracis muscle of Cobb-500 (43) and Ross (44) broiler strains showing perimysium, endomysium, muscle fiber, nucleus and blood vessel at 35th day of age. (H & E stain, 40x)

In conclusion it can be said that strain selection and age of the bird are two significant criteria in meat industry for improving meat characteristics which distinctly affect the profitability. Ross broiler strain has a better meat characteristics for its lower fat and collagen content in comparision to those of Cobb-500 broiler strain.

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