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Research Article

Influence of Age and Breed on the Muscle Nutrient Content of Slow- and Fast-Growing Birds under Similar Management

Ibitoye EB[1*]; Nur Mahiza MI[2]; Lokman HI[3]

[1]Department of Theriogenology and Animal Production, Faculty of Veterinary Medicine, Usmanu Danfodiyo University Sokoto, Nigeria

[2]Department of Pathology and Microbiology, Faculty of Veterinary Medicine, Universiti Putra Malaysia

[3]Department of Pre-Clinical Sciences, Faculty of Veterinary Medicine, Universiti Putra Malaysia

***Corresponding author:** **Ibitoye EB**
Department of Theriogenology and Animal Production, Faculty of Veterinary Medicine, Usmanu Danfodiyo University Sokoto, Nigeria.
Tel: +234 7038 2282 00
Email: eb.ibitoye@gmail.com

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Abstract

Traditional free-range, slow-growing bird rearing is critical to household food security and poverty alleviation in developing countries. This study evaluated the proximate and collagen contents of the breast and thigh muscles of Red Jungle fowl (RJ), Village Chicken (VC) (slow-growing birds), and Commercial Broilers (CB) (fast-growing birds). Fifty each of the RJ, VC, and CB day-old chicks were raised under similar management. They were randomized into three groups according to breed (JV, VC, and CB), in five replicates, using cages (1.2m×1.2m×0.6m) from day old till the end of the experiment. They were fed a commercial diet and were allowed to drink water ad libitum for 120 days. Ten chickens per breed or group were serially euthanized, and their pectoralis major (breast muscle) and biceps femoris (thigh muscle) were evaluated for moisture, ash, crude protein, and collagen. The moisture in the RJ breast was lower ($p \leq 0.05$) than in the VC and CB, while it decreased ($p \leq 0.05$) with age. The crude protein in RJ and VC was higher ($p \leq 0.05$) than in CB and at an earlier age ($p \leq 0.05$) than at older ages. Collagen increased with age for all breeds evaluated; it was highest ($p \leq 0.05$) in RJ, least in CB, and higher in the thigh than in the breast. The nutrient composition differs between these birds, although they were raised under similar management. It was concluded that the age and breed of the bird influence the nutrient content of the RJ, VC, and CB muscles.

Keywords: Breast and thigh muscles; Collagen; Crude protein; Fast-growing Birds; Slow-growing birds

Abbreviations: RJ: Red Jungle Fowl; VC: Village Chicken; CB: Commercial Broilers

Introduction

In general, meat comprises approximately 72-75% water, 19% protein, 3.5% soluble non-protein substances, 2.5-5% fat, 1.5% non-protein nitrogen compounds, 1% non-nitrogenous compounds (vitamins), and carbohydrates, and 1% ash [1]. The variability in chemical composition and quality of muscle is related to several factors, i.e., species, breeds, sex, age, nutrition, and genetics of the animal, as well as the location and physical exercise of the muscle [2]. Breeds exert the most general intrinsic influence on the biochemistry and constitution of muscle [3]. There is also a genotype effect on the protein content of breast meat, as described by [4,5], who reported that slow-growing birds had higher protein content than fast-growing ones. Typically, the compositions of the body and muscle change as the animal ages [6]. In general, most parameters such as the intramuscular fat and protein increase while the moisture content decreases [7] and the number of collagen increases. According to [8], the general effects of nutrition on the growth of meat are reflected in the composition of individual muscles. A high level of nutrition will increase the percentage of intramuscular fat and decrease the percentage of moisture [9], while undernutrition will cause a marked increase in muscle water content associated with an increase in the percentage of intramuscular collagen [10].

The least understood of the intrinsic factors that affect muscle constitution is the variability between individual animals [11]. In poultry, there are different species and breeds of chicken, such as jungle fowl (*Gallus gallus*), indigenous chickens (*Gallus gallus domesticus*), and broilers (*Gallus domesticus*). Modern broilers are typically descendants of red jungle fowl

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[12]. The red jungle fowl are known to be omnivores, having insects, young leaves, seeds, and fruits of many plant species as their diets. As for the village chickens, they are the progeny of a cross between red jungle fowl and a mixed exotic domestic breed that was brought by the Britons. They usually feed once or twice a day with an assortment of remnants such as rice or used coconut pulp and are known to have poor production performance [12]. They are free-ranging and cheap and easy to raise [13]. In Malaysia, most of the studies done on the Red Jungle fowl (RJ) and Village Chicken (VC) have focused on their development, rearing systems, and diseases [14]. Data on their nutrient compositions on a chronological age basis is lacking. Thus, this experiment was to determine and compare the nutrient content of breast and thigh muscles in the slow-growing RJ and VC and the fast-growing CB breed.

Materials and Methods

Animals and Experimental Design

The experimental house was located at N 03.00551º and E 101.70501º at Universiti Putra Malaysia. A total of 150-day-old chicks of both sexes, consisting of 50 each of Red Jungle Fowl (RJ) (*Gallus gallus spadiceous*), Malaysian Village Chicken (VC) (*Gallus gallus domesticus*), and Commercial Broiler (CB) (Ross), were used for this study. In a completely randomized design, the chicks were allotted into 3 groups of 50 birds each according to breed (JV, VC, and CB), and replicated five times with 10 birds per replicate. These three breeds of chicken were individually reared in three different cages (1.2m×1.2m×0.6m) in the experimental house from day old until the end of the experiment (day 120). They were fed a commercial diet and allowed to drink water *ad libitum*, and the concentration of crude nutrients in their diets is shown in Table 1. For both the RJ and VC, their eggs were obtained from Jenderam Hulu, Sepang, Selangor, and were hatched in the laboratory using a hatchery. The CB chickens were obtained from a private hatchery in Taiping, Perak, Malaysia.

Table 1: The concentration of crude nutrients in the feed (201-C and 203-P).

Type of diet	CP (%)	Crude Fat (%)	Ash (%)	Moisture (%)	ME (kcal/kg)
201-C (Starter)	22.9	5.0	8.0	13.2	2795
203-P (Finisher)	18.0	5.5	8.0	13.0	2897

Sample Collection and Preparation

Ten birds were randomly selected from each group at each of the ages of day 1, 10, 20, 56, and 120 post-hatch and were sacrificed by intravenous (cutaneous ulnar vein) administration of sodium pentobarbitone (80mg/kg). The pectoralis major and biceps femoris were harvested and used as the representatives of the breast and thigh muscles, respectively. These samples were analyzed for moisture, dry matter, crude protein, and ash content [15]. The moisture and dry matter contents were analyzed using the oven method, the ash content was determined with a furnace at 600℃, while crude protein was determined according to the Kjeldahl method. The total collagen analyses were determined by direct measurement of hydroxyproline after acid hydrolysis, as described by [16].

Ethical Approval

The Ethics Committee for Animal Use of the Faculty of Veterinary Medicine, Universiti Putra Malaysia, evaluated and approved the study design (approval certificate no. 08R24/JULAI08-JUN09).

Statistical Analysis

The data generated from proximate analysis and the collagen composition of the breast and thigh muscles were analyzed using one-way ANOVA, and Duncan's multiple range tests were used to elucidate differing means (SPSS, 17.0). The means for breast and thigh muscle samples were compared using an independent sample T-test.

Results

Proximate Analysis of Breast and Thigh Muscles

The mean percentage of moisture in the breast muscles of RJ, VC, and CB is shown in Table 2. It was observed that the percentage of moisture in breast muscle among the breeds showed no difference ($p \geq 0.05$) except at day 20 post-hatch, while the moisture content in RJ was lower ($p \leq 0.05$) than in VC and CB. Within all the breeds evaluated, the mean moisture content was higher at an early age (days 1 and 10 post-hatch) and lowered ($p \leq 0.05$) as the age increased. For RJ, VC, and CB, the results showed that the mean moisture content was significantly higher at days 1 and 10 post-hatch but not significantly

Table 2: Mean percentage moisture, ash, and crude protein of breast and thigh muscles in RJ, VC, and CB at different ages (mean±SE; n=10).

Age post-hatch	Breast muscle			Thigh muscle		
	Moisture					
	RJ	VC	CB	RJ	VC	CB
Day 1	79.26±0.21 ^{v}	78.48±0.63 ^{v}	79.61±0.31 ^{v}	69.67±2.52 $^{b, v}$	72.65±0.86 $^{a, b, x, v}$	77.25±0.50 $^{a, v}$
Day 10	74.20±0.80 ^{v}	75.31±0.55 ^{v}	75.38±0.55 ^{v}	72.23±0.87 $^{b, v, w}$	71.12±1.26 $^{b, v}$	76.81±1.85 $^{a, v}$
Day 20	73.56±0.22 $^{b, w}$	74.80±0.16 $^{a, w, x}$	74.20±0.14 $^{a, w, x}$	74.05±0.53 $^{a, b, w, x}$	72.90±0.90 $^{b, v, w}$	75.71±0.61 $^{a, v}$
Day 56	73.27±0.54 ^{w}	74.40±0.28 $^{w, x}$	73.91±0.45 $^{w, x}$	73.65±0.46 $^{b, w, x}$	75.97±0.26 $^{a, x}$	76.08±0.47 $^{a, v}$
Day 120	73.20±1.33 ^{w}	73.85±0.30 ^{x}	72.96±0.68 ^{x}	75.57±0.42 $^{a, x}$	75.22±0.73 $^{a, w, x}$	75.78±0.44 $^{a, v}$
	Ash					
Day 1	0.31±0.07 ^{b}	0.44±0.02 $^{b, v}$	0.82±0.15 $^{a, v}$	0.40±0.03 $^{a, v}$	0.44±0.08 $^{a, v, w}$	0.25±0.01 $^{b, v}$
Day 10	0.37±0.07 ^{a}	0.19±0.04 $^{b, w}$	0.33±0.03 $^{a, b, w}$	0.27±0.03 ^{w}	0.36±0.06 $^{v, w}$	0.32±0.04 $^{v, w}$
Day 20	0.51±0.05 ^{a}	0.52±0.04 $^{a, v}$	0.31±0.01 $^{b, w}$	0.34±0.02 $^{b, v}$	0.53±0.08 $^{a, w}$	0.30±0.01 $^{b, v, w}$
Day 56	0.39±0.01 $^{a, b}$	0.35±0.02 $^{b, v, w}$	0.43±0.03 $^{a, w}$	0.35±0.02 ^{v}	0.34±0.02 ^{v}	0.39±0.06 ^{w}
Day 120	0.59±0.19 ^{a}	0.48±0.10 $^{b, v}$	0.49±0.02 $^{b, w}$	0.27±0.01 ^{w}	0.31±0.01 ^{v}	0.31±0.01 $^{v, w}$
	Crude protein					
Day 1	20.57±0.46 ^{w}	22.09±1.12 ^{v}	24.06±1.50 ^{v}	19.61±0.19 $^{b, v}$	23.31±1.13 $^{a, v}$	18.63±0.60 $^{b, v}$
Day 10	22.47±0.44 ^{v}	21.45±0.60 ^{v}	22.16±0.44 ^{w}	21.31±0.56 $^{a, w, x}$	20.72±0.39 $^{a, w}$	20.54±0.50 $^{a, w}$
Day 20	22.07±0.49 $^{a, v}$	21.87±0.31 $^{a, v}$	18.89±0.17 $^{b, x}$	20.37±0.36 $^{a, b, v, w}$	21.01±0.25 $^{a, w}$	19.71±0.20 $^{b, v, w}$
Day 56	20.36±0.20 $^{a, w}$	20.26±0.19 $^{a, w}$	19.57±0.31 $^{b, x}$	20.88±0.42 $^{a, w, x}$	21.28±0.39 $^{a, w}$	20.99±0.39 $^{a, w}$
Day 120	19.78±0.38 ^{w}	20.40±0.33 ^{w}	20.05±0.32 ^{x}	21.74±0.30 $^{a, x}$	21.65±0.22 $^{a, w}$	20.37±0.56 $^{b, w}$

$^{a, b}$ Mean values within the same row and $^{v, w, x}$ mean values within the same column with different superscripts were significantly different ($p<0.05$).
RJ: Red Jungle Fowl; VC: Village Chicken; CB: Commercial Broiler; SE: Standard Error

different as the age increased. The mean percentage of ash in RJ was lower than in CB on day 1 and higher on days 20, and 120 post-hatch. A comparison between RJ and VC revealed that the percentage of ash at days 10 and 120 post-hatch in RJ was higher ($p \leq 0.05$), while that of the VC was lower ($p<0.05$) than that in CB at days 1 and 56 post-hatch. Within the breeds, for VC and CB, there was a significant decrease in percentage ash from days 1 to 10 post-hatch but not significant ($p \geq 0.05$) there after or for RJ. For crude protein content, there was no significant difference ($p \geq 0.05$) at an early age (days 1 and 10 post-hatch) in the three breeds evaluated. At days 20 and 56 post-hatch, the RJ and VC breast muscles were observed to be significantly higher ($p \leq 0.05$) in crude protein than the CB breast muscle, while no difference ($p \geq 0.05$) was seen at day 120 post-hatch for all the breeds. Within the breed, the mean percentage of crude protein in RJ showed a significant increase ($p \leq 0.05$) from days 1 to 10 post-hatch, while there was a numerically decreasing ($p \geq 0.05$) pattern as the age increased. Within the VC breast muscle, there were no differences at days 1, 10, and 20 post-hatch, but a significant decrease at days 20 and 56 post-hatch was recorded, and for the CB breast muscle, the results showed that the mean percentage of crude protein was decreased ($p \leq 0.05$) from days 1 to 10 post-hatch.

Table 2 also shows that the mean percentage of moisture in RJ and VC thigh muscles was lower than in CB at all ages evaluated but was only significant ($p \leq 0.05$) at days 1, 10, and 56 for RJ and at days 10, and 20 post-hatch for VC. The percentage of moisture between RJ and VC differed non-significantly, except at day 56 post-hatch, where it was lower ($p \leq 0.05$) in RJ than in VC. Within the breed, the moisture content of RJ and VC thigh muscles increased non-significantly with an increase in age. The moisture content of the RJ thigh muscle was significantly higher in older birds, but there was no difference at days 10, 20, 56, and 120 post-hatch. Although a slight increase in moisture was observed in the VC thigh muscle, there was no difference ($p \geq 0.05$) on days 1, 10, and 20, but moisture significantly increased at days 20–56 post-hatch. Within the CB thigh muscle, the mean moisture percentage was not affected ($p \geq 0.05$) by age. The ash content in the RJ thigh muscles was higher ($p \leq 0.05$) than in the CB on day 1 post-hatch but showed no difference ($p \geq 0.05$) as the age increased. The ash content of the RJ thigh muscle decreased significantly by day 20, whereas the ash content of the VC thigh muscle was significantly higher (p0.05) than that of the CB on days 1 and 20 post-hatch. Within the breeds, the mean ash content in RJ decreased with an increase in age but was only significantly different ($p \leq 0.05$) at days 1 to 10 and days 56 to 120. In the VC thigh muscle, the ash content decreases as the age increases, but this is only significant between days 20 and 56 post-hatch. Within the CB thigh muscle, there was a slight numerical increase in the ash content as the age increased. Significantly, the protein content in RJ thigh muscles was higher than in CB at day 120, lower in RJ than in VC at day 1, and higher in VC than in CB at days 1, 20, and 120 post-hatch. Within the breed, RJ showed a significant ($p \leq 0.05$) increase in crude protein content from days 1 to 10, while within the VC thigh muscle, the crude protein significantly decreased from days 1 to 10 post-hatch. There was a significant change in the protein content of CB thigh muscles from days 1 to 10 post-hatch.

Comparison between the Proximate Analyses of Breast and Thigh Muscles between RJ, VC, and CB

The moisture, ash, and crude protein in the breast and thigh muscles of RJ, VC, and CB at different ages are shown in Table 1. On day 1 post-hatch, the moisture content of RJ was higher ($p \leq 0.05$) and the dry matter was lower ($p \leq 0.05$) in the breast muscles, while there were no differences in the ash and protein contents in the breast and thigh muscles, although the values were higher in the breast muscle. At day 20 post-hatch, the ash and protein contents in the breast muscle were higher ($p \leq 0.05$), while the crude protein content was significantly higher in the thigh muscle at day 120 post-hatch. At days 1 and 10 post-hatch, the moisture content of VC was higher ($p \leq 0.05$) in the breast muscle, its ash content was lower ($p \leq 0.05$), and there was no difference in protein content in either muscle at day 10. On day 20 post-hatch, the result was similar to that of day 10 in the moisture content, but the protein was higher ($p \leq 0.05$) in the breast muscle. At day 56 post-hatch, the breast muscle recorded a significant reduction in moisture and crude protein when compared to the thigh muscle, and at day 120 post-hatch, protein decreased ($p \leq 0.05$) in the breast muscle. On day 1 post-hatch, the moisture, ash, and crude protein content were higher ($p \leq 0.05$) in the breast muscle, while on day 20, post-hatch, the moisture and protein content were lower ($p \leq 0.05$) in the breast muscle. By days 56 and 120 post-hatch, moisture content continues to decrease ($p \leq 0.05$) in the breast muscle, but conversely, it contains a higher ($p \leq 0.05$) ash content than the thigh muscle at day 120 post-hatch. Crude protein was significantly higher in thigh muscle at day 56 post-hatch.

Collagen Analysis

Total Collagen Content in RJ, VC, and CB Breast Muscle at Various Ages

The total collagen content of RJ, VC, and CB breast and thigh muscles at different ages is shown in Table 3. Generally, the total collagen content of RJ and VC breast muscles at all ages assessed was higher ($p \leq 0.05$) than that of CB. The total collagen in the RJ was significantly higher on day 1, but there was no difference on days 10, 20, and 120 post-hatch compared to the VC. However, on day 56, the total collagen in the breast muscle of RJ was lower ($p \leq 0.05$) than in the VC. Within the breeds, the total collagen in the breast muscle for all the breeds increased as age increased. Significantly ($p \leq 0.05$), the total collagen content in the breast muscle of RJ increases from day 56 onward; it increases from day 20 onward in the VC, while in the CB, it increases only on day 120 post-hatch. Among the three breeds evaluated, the total collagen in the thigh muscle of the RJ was higher ($p \leq 0.05$) than in the CB at all ages evaluated. Similarly, when compared to the VC, the total collagen was higher in RJ, but only significantly different ($p \leq 0.05$) on days 1, 10, and 20 post-hatch. Total collagen content in the thigh muscle of the VC was significantly higher than in the CB except on day 1 post-hatch. Within the breeds, the total collagen in the thigh muscle for all three breeds increased as the age increased. The total collagen in the thigh muscle of RJ was higher ($p \leq 0.05$) at all age intervals, except on days 10 to 20 post-hatch. The total collagen in the thigh muscle of VC was significantly increased at all ages evaluated, with a similar pattern being observed in CB except on days 1–10 post-hatch.

Comparison between the Total Collagen in the Breast and Thigh Muscles of RJ, VC, and CB at Different Ages

The comparison of total collagen content in the breast and thigh muscles of RJ, VC, and CB at different ages is shown in Table 3. The results showed that the total collagen content was lower ($p \leq 0.05$) in the breast muscle of RJ at all ages evaluated, except on day 1 post-hatch. Similarly, for VC, the total collagen content was also lower in the breast muscle, except on day 1 post-hatch, where it was significantly higher than in the thigh muscle. The collagen content in the breast muscle lowered (p≤0.05) on days 56 and 120 post-hatch. In contrast, the collagen content of CB's breast muscle was numerically higher than that of the thigh muscle at younger ages, but it decreased significantly after day 20 post-hatch.

Table 3: Total collagen content in breast and thigh muscles (mg/g) of RJ, VC, and CB at different ages (mean±SE; n=7).

Age	Breast muscle		
	RJ (mg/g)	VC (mg/g)	CB (mg/g)
Day 1	1.75±0.17 a, y	1.31±0.12 b, z	0.43±0.09 c, x
Day 10	1.83±0.12 a, y	1.52±0.15 b, z	0.55±0.04 c, x
Day 20	2.27±0.26 b, y	2.48±0.21 a, y	0.72±0.16 c, x
Day 56	2.94±0.25 b, x	3.58±0.10 a, x	1.07±0.14 c, x
Day 120	5.21±0.32 a, w	4.52±0.21 a, w	2.54±0.43 b, w
	Thigh muscle		
Day 1	2.00±0.22 a, z	0.63±0.11 b, z	0.39±0.08 b, z
Day 10	4.01±0.15 a, y	1.89±0.24 b, y	0.51±0.17 c, z
Day 20	4.74±0.19 a, y	3.06±0.25 b, x	1.64±0.24 c, y
Day 56	5.57±0.17 a, x	5.26±0.15 a, w	3.18±0.10 b, x
Day 120	9.96±0.48 a, w	9.71±0.16 a, v	5.77±0.36 b, w

a, b, c Mean values within the same row and w, x, y, z mean values within the same column with different superscripts different significantly (p<0.05).
RJ: Red Jungle Fowl; VC: Village Chicken; CB: Commercial Broiler; SE: Standard Errors

Discussion

Proximate Analysis

In general, muscle is 75% water in various forms, such as immobilized, bound, and free water [111]. In this study, breeds had no effect on the moisture content of the breast muscle except at day 20 post-hatch, and in all breeds examined, the moisture content decreased as the age increased. The dry matter contents were inversely related to the moisture contents in the breast muscle. Also, breeds do not affect the dry matter content of the breast muscle. This agreed with the studies of [7] that showed an increase in age led to an increase in dry matter content. Thus, this may also explain why there was no difference in the moisture and dry matter content in the breast muscle between the slow-growing birds and the fast-growing birds. At all ages evaluated, the moisture contents in RJ and VC thigh muscles were lower, while the dry matters were higher than in the CB. The results were in agreement with Wattanachant *et al.* (2004). In general, the thigh muscle moisture content was lower in slow-growing birds than in fast-growing ones, and conversely, the dry matter in the thigh muscles was higher in slow-growing birds [17]. This difference in moisture content and slight variation in the ash content in the breast muscles of RJ, VC, and CB were suggested to have been due to different feeding behaviours [18], and according to [19], the chemical composition of chicken meat was influenced by species, sex, age, part of the meat, and carcass processing. The moisture content was significantly higher (p≤0.05) in the breast than in the thigh muscle. This may be explained using the "space" effect, also known as the Steric or Spatial Effect: here, the water-holding capacity of a muscle is related to the total volume of spaces between muscle cells and cellular compartments that can be filled with water. The rule of thumb is that longer sarcomeres, usually found in less contracted muscles like the breast muscle [20], have more "open" space available to trap or hold more water. Our results contradict the findings of [21], probably because of differences in the strains of birds and moisture content determination methods used. As for the CB, the moisture content in the breast muscle was significantly lower than in the thigh muscle.

The crude protein composition of RJ and VC breast muscles was higher (p≤0.05) than that of CB. This agreed with the findings of [17] and, more recently, Dalle Zotte *et al.* (2020). The results of this study revealed that there was only a minor difference in the crude protein composition of the thigh muscle among the breeds, with the slow-growing birds having a higher crude protein composition than the fast-growing birds. This result also agreed with the reports of Wattanachant *et al.* (2004), [17], and [21] that the crude protein in the thigh muscles of slow-growing birds was higher than that of fast-growing birds. The difference in the amount of crude protein in breast and thigh muscles among the breeds may also be related to the morphology of the avian small intestine, which is relatively longer and heavier in slow-growing birds than in fast-growing ones [22], hence, the difference in the number of nutrients absorbed. Therefore, concentrated selection for increased body weight in CB may have led to an increase in fat deposition and, consequently, a decrease in crude protein content [23]. Another reason is related to the activity of the birds, where high activity in RJ and VC birds might have led to a decrease in fat and an increase in protein. Within the breeds and for all breeds studied, the crude protein compositions at an early age were higher than those at an older age in the breast muscle. This is consistent with [24], finding that the tissue composition of poultry muscle varies with age as growth rates of tissue components differ across species [25]. This was also expected, as nutrition is an external factor with a major influence on the chemical composition of broiler meat [26]. The protein content in the starter diet (22.9%) given at days 1 to 20 post-hatch was higher than in the finisher diet (18.0%) given at days 56 to 120 post-hatch, thus the content of crude protein in the diet may reflect the composition of crude protein in the meat [27].

In young birds, the composition of crude protein in the breast was higher than that in thigh muscles, while in older birds, the composition of crude protein was significantly higher in the thigh muscle. This pattern is similar in all breeds evaluated in this study. However, this result contrasted with that of Wattanachant *et al.* (2004), who showed that crude protein in the breast muscle was higher than in the thigh muscle. This could be attributed to a difference in the breeds of chickens researched.

Collagen Analysis

This study found that the collagen composition of slow-growing birds was higher than that of fast-growing birds of all ages studied. This is in agreement with most of the previous studies [28], which stated that breed was among the important factors in collagen composition determination. Wattanachant *et al.* (2004) reported that the composition of total collagen in Thai indigenous chicken was higher than in the commercial broiler, and [29] also reported that native Aseel chicken has a higher collagen composition in the breast muscles as compared to the commercial broiler. However, there was a scarcity of reports on the collagen composition in the RJ. Within the breed, the results revealed that the composition of collagen increased with age, although without a significant difference (p≥0.05) at an early age. The increase in collagen in the breast muscle is in agreement with [10] and [28]. Higher slow-twitch muscle fibers, or Type-1 muscle fibers, with smaller fiber diameters in RJ and VC than in CB, may be to blame. In adult chickens, the muscle develops with a larger myofibril size, and the perimysium has to deposit many tough collagen fibers with various striations. Thus, the wider perimysium in the muscle could deposit more collagen fibers and increase total collagen.

The composition of collagen in the thigh muscle showed a similar pattern as the breast muscle, where it was highest in the RJ, followed by the VC, and least in the CB, although not significantly different at days 56 and 120 post-hatch when comparing between the RJ and the VC. The slower-growing birds have the highest collagen content compared to the faster-growing ones, and this was corroborated by [29] in a study that compared native Aseel chickens with commercial broilers. Similarly, [4] also reported that the total collagen content in the bicep femoris of the Thai indigenous chicken was higher than that found in broilers. The composition of total collagen in the breast and thigh muscles of the breeds showed a similar pattern. The composition of collagen was consistently higher in the thigh than in the breast muscle, although it showed variable composition at an early age (days 1 to 10 post-hatch). The smaller diameter of thigh muscle fibers compared to breast muscles, as well as the higher composition of type-1 fibers in the thigh compared to the breast muscles, could explain why the thigh muscle collagen composition was higher.

Conclusion

The age and breed of birds play an important role in the nutrient composition of the RJ, VC, and CB muscles. Slow-growing birds are richer in crude protein content at younger ages, while their collagen content is higher than that of fast-growing birds, and it increases with age.

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