Brazilian Journal of Poultry Science
Revista Brasileira de Ciência Avícola

e-ISSN: 1806-9061 2024 / v.26 / n.3 / 001-008

http://dx.doi.org/10.1590/1806-9061-2023-1880

Original Article

Musculoskeletal and Visceral Quality of Broilers with Different Body Patterns

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Keywords

Adiposity; Body composition; Bone density; Morphology, Poultry science.

Section editor: Nilsa Duarte da Silva Lima

Submitted: 13/November/2023
Approved: 27/June/2024

ABSTRACT

The growth pattern of broilers can be influenced by diets, environment, stress, health and management. Considering the relevance of the body structure of broilers for slaughterhouse condemnations, the aim of this study was to analyze the body composition, bone mineral density (BMD), and musculoskeletal and visceral morphology of broilers with different body attributes from commercial slaughterhouses. Forty-eight plucked broilers from two different strains were distributed into three groups: standard, uneven, and cachectic. The broilers were evaluated for lean mass, body fat, BMD, and bone mineral content (BMC), and subject to macroscopic, musculoskeletal and visceral analyses. It was found that BMD was lower in the uneven and cachectic groups compared to the standard ($p \leq 0.05$), and cachectic broilers had a lower BMC compared to the other groups. The body weight of broilers in the standard group was greater compared to the other groups, while the relative weight of the proventriculus, gizzard, liver, duodenum, jejunum, cardiovascular structures, and kidney was greater among the cachectic in comparison to the others. The uneven group presented intermediate mean values for several densitometric and morphological parameters, as well as no statistical difference ($p \geq 0.05$) to the standard group in the weight of the proventriculus, spleen and kidneys, the weight and the length of duodenum, the length and diameter of the gastrocnemius, and the diameter of the sartorius muscle. It is possible to conclude that uneven broilers have similar characteristics to the standard group, demonstrating that they could be used as feedstock for processed products, reducing economic losses at the slaughterhouse.

INTRODUCTION

With the increase in poultry productivity, consumer demand for safeguarding animal health and food quality grows. Despite Brazil occupying a prominent position in global poultry farming, failures related to carcass quality and a large number of condemnations result in significant economic losses for the segment (Oliveira *et al.*, 2021).

Factors such as nutritional and sanitary management and inadequate environmental conditions are the main causes of broilers carcass condemnation. The three most frequent causes are cachexia (42%), generalized congestion (29%), and non-purulent skin lesions (14%) (Salines *et al.*, 2017). Advanced monitoring and control systems using automated poultry farming processes could minimize these issues, optimizing production and producing standardized flocks (George & George, 2023).

Cachectic broilers are one of the main types of comdemned carcasses (Ferreira *et al.*, 2012), being characterized by decreased muscle size and strength, protuberance of the sternum, lack of body fat, and a purplish appearance of the muscle tissue in the carcass. The highest number of carcass condemnations recorded this year was 107,988, in the month of June, in the state of Paraná (Brazil, 2023).

Several conditions can trigger cachexia, but the most common causes are related to malnutrition and infectious diseases. Although cachectic carcasses have a darkened color, Qiao *et al.* (2001) mention that pre-slaughter management and genetic predisposition are the main factors causing it.

Uneven flocks can be rejected at the slaughterhouse. This is a challenge faced in the poultry industry, which occurs especially when the housing density is greater than 30 kg/m² (6.2 lb/ft²) in open houses with fans, and 42 kg/m² (8.6 lb/ft²) in closed houses with tunnel ventilation (Cobb-Vantress, 2018). This situation results in competition among broilers for space in beds, feeders and drinkers, favoring dominant chickens that have more access to these resources and show greater weight gain compared to other broilers. This scenario results in uneven avian growth, which negatively influences final performance and carcass yield (Luchesi, 1998).

According to Araújo *et al.* (2012), bone growth does not keep up with rapid muscle growth in modern chicken strains, resulting in a higher incidence of leg problems and bone fragility. Furthermore, artificial selection has resulted in developmental trade-offs, with the reallocation of resources to maximize nutrient absorption and pectoral muscle mass coinciding with relative decreases in the size of other organs, such as the heart and brain (Schmidt *et al.*, 2009).

In addition to musculoskeletal characteristics and adiposity, broiler carcasses may present variations in the structure of the digestive tract, which according to Szczepańczyk (1999), are mainly related to the weight, length, and width of the different segments.

Highlighting the literature cited above, the present study aimed to analyze the structural aspects of different broilers parts through the evaluation of mineral density and content, lean mass and body fat, musculoskeletal and morphological characteristics of different organic systems; thus verifying whether uneven broilers could be used as feedstock in processed products, and reduce economic losses in the slaughterhouse.

MATERIALS AND METHODS

This study was approved by the Ethics Committee on the Use of Animals from São Paulo State University, (Unesp), School School of Agricultural and Veterinary Science, Protocol no. 3689/21. The broiler chickens were slaughtered at 42 days of age, and consisted of males and females from the Cobb 500 and Ross lines originating from a commercial slaughterhouse (state of São Paulo, Brazil). The classification and selection of broilers according to sex was carried out in the hatchery, while the selection of groups was made at the slaughterhouse, according to weight and muscle coverage immediately after plucking. The distribution was carried out in a randomized block design with three groups with 16 broilers each: standard (n=16) (adequate body weight and muscle coverage), uneven (n=16) (lower average body weight than the standard group and less muscle coverage), and cachectic (n=16) (reduced size and weight, muscle atrophy characterized mainly by insufficient coverage of the pectoral muscle and prominence of the sternum) (Figure 1), according to the classification established by RIISPOA (Brazil, 2020). Then, the plucked broilers were placed in refrigerated boxes and transported to the Multi-user Laboratory for Body Composition Studies, Bone Densitometry, Bone Strength and Tissue Morphometry of the Department of Morphology and Animal Physiology of the Faculty of Agricultural and Veterinary Sciences of Jaboticabal to analyse the lean mass and total bone mineral density.

Figure 1 – Adult plucked broilers. A: standard (1); B: uneven and (2); C: cachectic broiler. Source: Morpholab, 2022.

The plucked broilers were individually weighed, and their total length were calculated with a common millimeter measuring tape. The Hologic®, Discovery Si, GE dual-energy X-ray absorptiometry (DXA) was calibrated, and each broiler was positioned in supine position to avoid bone overproposition. Body scanning was performed, and the values of bone mineral density (BMD) (g), bone mineral content (BMC) (g), lean mass (%), and body fat (g) were estimated.

After analysis by DXA, the general appearance of each broiler was evaluated, following photodocumentation and dissection for visceral, muscular and bone analysis. To analyze the viscera, immediately after opening the coelomic cavity, the air sacs were inspected and classified according to color, and presence of exudate and fibrin. The heart, lungs, proventriculus, liver, muscular ventricle, intestines, pancreas, and kidneys were inspected and classified according to color, weight, consistency (normal, firm, or friable), shape, size, and presence of lesions. The relative weight of the organs of interest was also calculated. Furthermore, the fat present in the coelomic cavity, and the abdominal region, and the adipose tissue around the proventriculus, empty gizzard, and intestines, were dissected and weighed. The liver was evaluated for normal (brown) or altered (yellowish or greenish) color, presence of spots, and focal or multifocal lesions. The cecal tonsils were incised and dissected at the ileocecal junction. The muscles were individualized and weighed, and the pectoral, gastrocnemius, and sartorius muscles were dissected, weighed, and measured. Then, the femur and tibia were removed, weighed and evaluated regarding the length and the perimeters of the proximal epiphysis, diaphysis, and distal epiphysis (respecting the contours) of the respective bones of the right pelvic limbs of broilers from the different groups.

Data consistency and analysis of variance (ANOVA) were performed using the R software, and the averages of the results obtained were compared using the least significant difference (LSD) test. Statistically significant differences were found when p-value was less than 5% ($p<0.05$). Data were expressed as arithmetic averages with their respective standard deviations.

RESULTS AND DISCUSSION

In Table 1, the standard group presented the highest BMD values (0.13g), differing from the uneven and cachectic groups ($p\leq0.05$), which presented equal values (0.12g) ($p\geq0.05$). For BMC, a difference was observed among the three groups ($p\leq0.05$), with the highest value for the standard group (40.16g), and the lowest for the cachectic group (22.80g). It was observed, therefore, that the skeleton of plucked broilers from the standard group was denser and probably had greater bone area and thickness, reflecting in greater BMC in relation to the other groups. Bone is a dynamic tissue that undergoes physiological processes of formation and resorption, with phases finely regulated by local or systemic factors that mediate the connections among osteoblasts, osteocytes, and osteosclates to maintain homeostasis (Kim & Koh, 2019). Therefore, it is suggested that these processes may be unbalanced in uneven and cachectic broilers, resulting in loss of density and bone mineral content, and, consequently, lower bone quality.

Regarding lean mass and body fat, there was a significant difference among groups ($p\leq0.05$). The standard group had the highest amount of lean mass and body fat in relation to the other groups, with the uneven and cachectic groups also differing significantly ($p\leq0.05$). Lee *et al.* (2007) observed that mice that suffered depletion of the gene that expresses osteocalcin in osteoblasts presented decreased β-cell proliferation, glucose intolerance, and insulin resistance. Therefore, they concluded that the skeleton plays a neuroendocrine role, controlling the body's energy metabolism. Thus, the results of the present study suggest that the loss of lean mass and body fat in uneven and cachectic broilers could be related to lower bone quality in these groups of broilers, probably due to the smaller population of osteoblasts and reduced amount of osteocalcin, which acts as a hormone, controlling energy metabolism in mammals (Lee *et al.*, 2007).

Furthermore, according to Argiles *et al.* (2015), several tissues are involved in cachexia, which characterized by loss of body weight, muscle and adipose atrophy, and inflammation, often being associated with anorexia. It is noteworthy that muscle tissue appears to be one of the main tissues involved in atrophy during cachexia. Sarcopenia is the degenerative loss of skeletal muscle mass, quality and strength, which characterizes the lower lean mass observed in the cachectic group (Table 1). The molecular mechanisms associated with cachexia and sarcopenia share some common trends. The loss of muscle mass is the result of a combination of imbalances between synthetic and degradative protein pathways, together with increased myocyte apoptosis, and decreased regenerative capacity. Oxidative pathways are also altered in skeletal muscles during loss of muscle mass, which appears to be a consequence of mitochondrial abnormalities that include altered morphology and function, with decreased ATP synthesis.

In the qualitative macroscopic analysis of the organs evaluated, it was observed that the standard and uneven groups didn't present visible changes in the liver and kidneys. In the uneven group, an increase in the cecal tonsils was observed in some broilers, with hemorrhagic changes evident after dissection (Figure 2A). In the cachectic group, kidney and liver alterations were found in some broilers. Figure 2B shows the kidneys from the standard group. Figure 2C shows that there was a change in the color in the kidneys, probably due to the presence of urate crystals, as described by Mallmnn & Dilkin (2020).

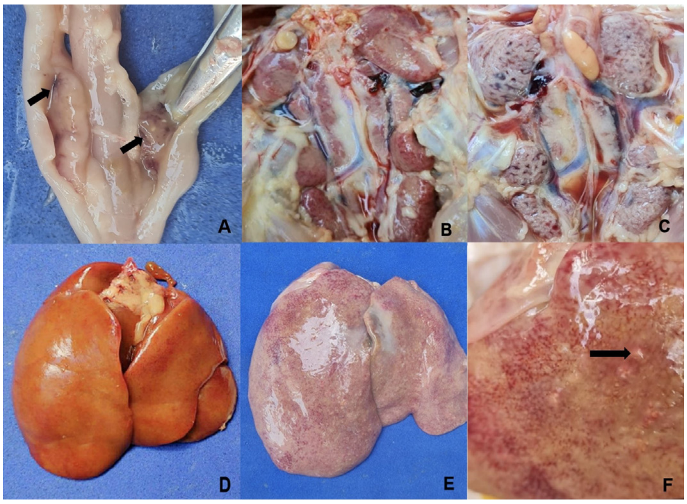

Figure 2 – Photographic images of cecal tonsils, kidneys and liver of broiler chickens. A: Hemorrhagic cecal tonsils of uneven chicken; B: kidney from the standard group; C: kidney from cachectic chicken; D: standard broiler liver; E: cachectic broiler liver; F: hepatic parenchyma with whitish nodules from cachectic broiler. Source: Morpholab, 2022.

In figure 2D, it can be seen that the liver has normal color and margins. In contrast, in images 2E and 2F, heterogeneous coloration of the liver is observed, with diffuse regions and increased contour of the organ, lesions suggestive of hepatitis. Palmeira-Borges *et al.* (2006) analyzed 400 broiler carcasses and observed macroscopic changes in 35% of them. These changes may be due to bacterial and parasitic infections, or toxicosis and cardiovascular disorders (Horrer, 1996). Barcelos *et al.* (2006) macro- and microscopically analyzed 100 liver samples from two different slaughterhouses and found macroscopic changes in 90 samples, 21 with a diagnosis of heterophilic cholangium hepatitis, and 9 with heterophilic pericolangitis. These lesions are suggestive of infection by *Clostidium perfringens* (Randal & Reece, 1996), which can compromise the broiler's development.

Table 1 contains all data from the morphologic analysis from the standard, uneven and cachectic groups. The cachectic group stood out with higher relative weight values compared to the other groups ($p \leq 0.05$) for some of the parameters evaluated. There was a significant difference ($p \leq 0.05$) among the three groups regarding the average weight of the broilers, and also body fat. In the research by Pereira *et al.* (2019), there was no difference in the weight of abdominal fat among the lines evaluated (Cobb 500 and Ross), but females had a higher percentage of body fat.

Kokoszyński *et al.* (2017) studied the morphological characteristics of different commercial strains and observed no effect of the genotype on the liver, heart, gizzard and spleen; while the proventriculus was heavier in one of the strains analyzed. In the present study, a difference ($p \leq 0.05$) was observed in the relative weight of these organs (Table 1), demonstrating that the broiler's size directly interferes in the viscera yield, due to the proportionality and body size in standard, uneven, and cachectic broilers.

In the present study, the relative weight of the liver was greater in the cachectic group compared to the standard group ($p \geq 0.05$), and (There was no significant difference between the two other groups.") it did not differ between the two other groups ($p \leq 0.05$). According to Palmeira-Borges *et al.* (2006), the liver is one of the organs most commonly affected in cachexia, and these authors observed 36% of broilers with liver alterations in a flock of 400 broiler chickens.

Researches related to the morphological aspects of the digestive system, such as Sousa *et al.* (2015), Ito & Miyaji (2020), Liboni *et al.* (2013), can contribute significantly to improving health and performance, as they are essential inputs for understanding the mechanisms responsible for the functioning of the digestive tract, especially in broiler chickens.

In the present work, the weight of some segments of the small intestine behaved differently (Table 1). The relative weight of the duodenum was greater in the cachectic group ($p \geq 0.05$), but did not differ between the standard and uneven groups ($p \geq 0.05$); while the weight of the jejunum and the ileum differed among the three groups ($p \geq 0.05$). Broiler health is linked to food, making the supply of a balanced diet essential. This is supported by Franzo *et al.* (2006), who showed low weight of organs in the digestive system in broiler chickens and layers subjected to dietary restriction.

Regarding the length of the intestinal segments (Table 1), it was observed that there was no statistical difference ($p \geq 0.05$) among the groups for the duodenum and ileum. In the jejunum, the standard group presented a higher average length compared to the other groups (134.56 cm), which did not differ from each other ($p \geq 0.05$). When analyzing the morphology of the small intestine of Cobb 500 chickens slaughtered at 46 days of age, Sousa *et al.* (2015) observed a shorter length of the jejunum (110.88 cm) when compared to the present study, and higher average values for the duodenum and ileum (32.38 and 20.25

cm, respectively). The three groups presented average values for the length of the ileum, similar to those observed in the literature, corroborating Ito & Miyaji (2020) who highlighted the length of 13 to 18 cm for this segment.

There was no difference in the weight of the pancreas ($p \geq 0.05$), only in the length of the standard group, which was greater ($p \leq 0.05$) in relation to the uneven and cachectic groups, which did not differ from each other (Table 1). According to López & Baião (2004) and Engberget *et al.* (2002), the type of diet can influence the size of the pancreas. The authors observed that broilers fed with coarse-grained rations had heavier pancreases compared to fed with medium-grained rations.

Regarding the proventriculus (Table 1), there was a significant difference ($p \leq 0.05$) among the weight values of the cachectic group in relation to the others. Diameter and length measurements were greater in the standard group, with no difference between the other two groups ($p \geq 0.05$). In the research by Nunes *et al.* (2011), replacing corn with sweet potato flour influenced proventriculus weight with decreasing quadratic and linear effects. Gonzáles-Alvarado *et al.* (2008) observed greater proventriculus weight in broiler chickens fed soybean hulls and rice instead of corn. According to the authors, the solubility capacity of soybean hulls in water promotes a reduction in the passage of food content from the proventriculus to the gizzard. The cachectic group presented higher relative weight values of the cardiorespiratory system organs and kidneys when compared to the other groups. The standard and uneven groups differed only in heart weight. The microscopic findings carried out by Nery *et al.* (2017) showed no presence or signs of infectious agents or microscopic lesions in the heart and kidneys of cachectic broilers, showing that not all cases of cachexia are due to infectious diseases.

Regarding the weight of the spleen (Table 1), it was observed that the values obtained for the three groups corroborated the literature, since, according to Nickel (1977), the spleen can weigh from 1.5g to 4.5g. The average weights found in the present research were from 1.92g to 3.07g.

As for the lungs, there was a significant difference between the cachectic and uneven groups ($p \leq 0.05$), and the standard group did not differ from both. The cachectic group presented the highest values, and the uneven group, the lowest (Table 1). As the lungs are susceptible to various avian diseases, Taunde *et al.* (2021) observed that colibacillosis affects the respiratory tract, compromising the body growth and leading to development of uneven broilers.

Regarding the kidneys, there was a statistical difference between the weight of the cachectic group in relation to the others ($p \leq 0.05$), but the standard group did not differ statistically from the uneven group (Table 1). Palmeira – Borges *et al.* (2006) evaluated lesions in 400 carcasses of cachectic chickens and found kidney lesions such as caseous exudate, yellowish color, and organ atrophy in 32 animals (8%). It is suggested that cachexia may affect the functioning of vital organs such as the kidney.

The femur weight of the standard group showed a significant difference ($p \leq 0.05$) in relation to the cachectic group, and the uneven group did not differ from either ($p \geq 0.05$). Barreiro *et al.* (2011) carried out research on the morphological parameters of chicken femurs at different growth stages and obtained an average of 14.96g, a result similar to that of the standard group in this research, 14.98g.

The length of the femur was greater in the standard group compared to the others ($p \leq 0.05$). It is suggested that the significant loss of lean mass may have affected the deposition of bone mass in the uneven and cachectic groups, since according to Buckner *et al.* (1950) the length of the femur correlates with the weight of the broiler, and the chickens in the standard group had greater length compared to the other groups.

The diameters of the proximal epiphysis, diaphysis, and distal epiphysis of the femur had a similar behavior to the length, with the standard group standing out with higher average values ($p \leq 0.05$) in relation to the others, which did not differ from each other ($P \geq 0.05$). In a study by Bruno (2002), diaphysis length and femur diameter values were reduced after food restriction. Kwakkel *et al.* (1998) showed that the femur may be more sensitive to bone modeling. Furthermore, according to Applegate & Lilburn (2002), femoral morphological changes are faster and more intense than tibial ones, and are associated with a greater number of bone disorders in fast-growing chickens.

The average weight, length, and diameter of the proximal epiphysis of the tibia in the standard group were significantly different ($p \leq 0.05$) in relation to the others, which did not differ from each other ($p \geq 0.05$). There was no statistical difference ($p \geq 0.05$) in the diameter of the tibial shaft among the groups. It is suggested that the loss of compact bone predominant in the diaphysis is slower in relation to epiphyses, made up predominantly of cancellous bone. In the research by Murakami *et al.* (2009), weight and tibia length values were similar (24g and 12cm) to those found in the present research for groups of chickens considered to be standard (23.54g and 11.88cm). The distal epiphysis of the tibia differed among the three groups ($p \leq 0.05$), being larger in the standard group and smaller in the uneven group (Table 1).

According to Almeida Paz & Bruno (2006), adequate nutritional levels promote the normal development of bone tissue. Therefore, it is inferred that the lower values presented by the uneven and cachectic groups may be related to the difficulty in accessing the feeders, potentially leading the amount of feed ingested not supplying broilers' needs.

In the macroscopic analysis of the muscles (Table 1), it was observed that the standard group presented the highest value for the relative weight of the pectoral muscle ($p \leq 0.05$) compared to the uneven and cachectic groups. There was no statistical difference ($p \geq 0.05$) in the relative weights of the gastrocnemius and m. sartorius among groups. The length and diameter of m. gastrocnemius did not differ among the standard and uneven groups, but differed between them and the cachectic group ($p \leq 0.05$). The length of m. sartorius was greater in the standard group ($p \leq 0.05$), and equal for uneven and cachectic groups.

Pereira *et al.* (2019), analyzed different strains and observed no statistical differences for pectoral muscle weight between the Cobb 500 and Ross strains and between sexes. According to Oliveira *et al.* (2014), inadequate temperatures can harm broilers' performances, contributing to a greater frequency of cachexia and unevenness in batches. Oliveira *et al.* (2006) evaluated carcass performance and observed a negative effect of high and low temperatures (32ºC and 16ºC) on the breast weight of broiler chickens.

When analyzing histopathological changes in the sartorius, cardiac, pectoralis latissimus dorsi muscles and sciatic and optic nerves of broiler chickens, Mazzucatto *et al.* (2009) observed that the sartorius muscle was the most affected by injuries. Inflammatory infiltrates were found between the fibers and perimysium, as well as fibers in degeneration phase and atrophy of muscle fibers. The connective tissue sheaths between the fibers and bundles appeared thickened. It is suggested that m. sartorius may be more sensitive to the drugs used in the experiment (monensin and roxarson) than other muscles, and histopathological changes may influence the visual appearance of the muscle.

Regarding the gastrocnemius muscle, Rosa *et al.* (2018), when analyzing the performance of chicken carcasses, found that the addition of creatine to the diet increased the presence of slow-twitch red fibers and fast-twitch white fibers. Other research showed that ingesting 1% pectin reduced lipid concentration in the gastrocnemius muscle (Silva, 2012).

It is also noteworthy that cachexia causes distinct changes in striated muscles, with skeletal muscle loss being progressive and faster when compared to cardiac muscle. However, although there is no significant reduction in cardiac muscle mass, according to Rausch *et al.* (2021), cachexia is critical for the functionality of the organ, causing serious cardiac abnormalities such as heart failure.

CONCLUSIONS

The long bones of the pelvic limb present site-specific morphological variations in different conformational patterns of broiler chickens. Understanding the bone characteristics of uneven and cachectic broilers requires future studies on the proportion of compact and spongy bone tissue.

Lower adiposity and reduced lean and bone mass affect the body composition of uneven and cachectic broilers. Cachexia, as a systemic syndrome, causes a significant reduction in musculoskeletal quality and interferes with the proportionality of organs of commercial interest, especially the heart and gastrointestinal tract.

Macroscopic analysis showed that several structures of the uneven group have similar characteristics to the standard group, demonstrating that uneven broilers could be used as feedstock for processed products, reducing economic losses at the slaughterhouse.

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Table 1 – Morphological analysis in standard, uneven, and cachetic broiler chickens slaughtered at 42 days of age.

Parameter	Standard	Uneven	Cachetic	*p*-value	CV	Parameter	Standard	Uneven	Cachetic	*p*-value	CV
BMD g/cm²	0.13 ^{a}	0.12 ^{b}	0.12 ^{b}	0.020*	10.45	Prov L cm	5.30^{a}	4.62 ^{b}	4.73 ^{b}	0.02*	14.20
BMC g	40.16 ^{a}	27.62 ^{b}	22.80 ^{c}	2.071e-10 ***	19.22	Duo L cm	29.50	29.25	27.41	0.51	13.45
LM g	2486.99 ^{a}	1568.29 ^{b}	1152.13 ^{c}	2.2e-16 ***	16.44	Jej L cm	134.56 ^{a}	115.80 ^{b}	108.06 ^{b}	9.821e-05***	41.38
BF g	590.14 ^{a}	369.06 ^{b}	262.80 ^{c}	1.449e-11***	24.25	Ileum L cm	19.31	16.07	17.51	0.17	26.56
CW Kg	2.96 ^{a}	2.09 ^{b}	1.50 ^{c}	2.2e-16 ***	13.43	Femur W kg	14.98 ^{a}	13.34 ^{ab}	12.07 ^{b}	0.011*	18.72
Ab Fat %	0.21 ^{a}	0.17 ^{b}	0.16 ^{a}	0.28	42.12	Femur L kg	8.13 ^{a}	7.50 ^{b}	7.03 ^{c}	2.895e-06***	18.72
Prov %	0.35 ^{b}	0.37 ^{b}	0.53 ^{a}	0.001***	22.06	DEPF cm	7.39 ^{a}	6.52 ^{b}	6.44 ^{b}	0.002**	6.68
Giz %	0.11 ^{b}	0.14 ^{a}	0.15 ^{a}	0.001***	14.20	DDiaF cm	3.58 ^{a}	3.24 ^{b}	3.31 ^{b}	0.017*	9.30
Liv %	0.19 ^{b}	0.14 ^{a}	0.26 ^{a}	0.001***	16.27	DDEF cm	8.11 ^{a}	7.02 ^{b}	6.81 ^{b}	4.107e-05***	11.03
Pan %	0.17	0.23 ^{ab}	0.20	0.07	21.08	Tibia L cm	11.88 ^{a}	10.19 ^{b}	9.90 ^{b}	6.003e-06 ***	20.41
Duo %	0.42 ^{b}	0.52 ^{b}	0.70 ^{a}	0.002***	20.43	PTED cm	8.93 ^{a}	7.58 ^{b}	7.72 ^{b}	7.13e-05***	9.34
Jej %	0.16	0.19	0.20	0.42	23.83	TDD cm	3.23	2.92	2.99	0.191	14.71
Ileum %	0.24	0.23	0.29	0.19	35.99	DEDT cm	8.14 ^{a}	6.82 ^{c}	7.28 ^{b}	8.099e-07***	7.22
Heart %	0.45^{C}	0.42 ^{b}	0.64 ^{a}	6.018e-05 ***	23.30	Pectoral %	0.32 ^{a}	0.28 ^{b}	0.25 ^{c}	2.776e-05***	44.69
Spleen %	0.10 ^{b}	0.90 ^{b}	0.13 ^{a}	0.002 **	30.75	Gast %	0.47	0.41	0.39	0.099	26.01
Lungs %	0.59 ^{ab}	0.56 ^{b}	0.65 ^{a}	0.072	18.48	Sartorius %	0.41	0.39	0.38	0.864	47.38
Kidneys %	0.60 ^{b}	0.59 ^{b}	0.84 ^{a}	2.664e-06 ***	20.28	Gast L cm	8.06 ^{a}	7.31 ^{a}	6.30 ^{b}	0.002**	47.38
Prov D cm	6.91 ^{a}	6.00 ^{b}	5.66 ^{b}	0.003**	31.60	Sartor L cm	9.55 ^{a}	8.19 ^{b}	7.69 ^{b}	0.004**	18.25
Panc L cm	13.19 ^{a}	10.75 ^{b}	10.87 ^{b}	0.001***	29.19	Gast D cm	7.44 ^{a}	7.00 ^{a}	5.45 ^{b}	4.39e-06 ***	15.57
						Sartor D cm	6.59 ^{a}	5.97 ^{a}	4.96^{b}	0.003**	22.16

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