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Body Conformation and Internal Organs Characteristics of Different Commercial Broiler Lines

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ABSTRACT

The aim of the study was to determine body weight and dimensions, body conformation, length of the esophagus, length of intestine and its segments, as well as weight of internal organs and their proportions relative the body weight of broiler chickens from three commercial lines - Ross 308, Hubbard Flex and Hubbard F15. At the age of 42 days, Ross 308 chickens had significantly ($p \leq 0.05$) shorter trunk, but greater chest circumference and compactness index, as well as shorter esophagus and longer large intestine compared with Hubbard F15. The longest large and total intestine was found in Ross 308 broilers. Chicken genotype had no significant effect on the percentage of the main internal organs, i.e. liver, heart, proventriculus, gizzard, and spleen. In the analyzed broilers, the coefficients of correlation between body weight and dimensions and the length of the esophagus, small intestine, caeca and large intestine were low and not significant. This study provides information relevant to breeding practice, including that the development of internal organs in broiler chickens raised under intensive conditions has an effect on their meat characteristics.

INTRODUCTION

Over the last few decades, broiler chicken performance has improved considerably, mainly as a result of selection for improved feed conversion and rapid rate of growth. The growth period was considerably reduced (to 5 or 6 weeks) and the proportion of breast muscle in the chicken body/carcass increased with a decrease in heart percentage (Schmidt, *et al*., 2009).

The selection of broiler chickens for rapid growth has a considerable influence on the development of muscle tissue and of the circulatory, digestive and nervous systems. In a study by Schmidt *et al*. (2009), the liver matured earlier and jejunal and ileal sections of the intestine were 20% longer in a modern broiler line (Ross 708) compared to a heritage line (UIUC) unselected since the 1950s. In another study, Lumpkins *et al*. (2010) showed that different genetic lines of broiler chickens have varying rates of intestinal development. Relatively shorter and lighter jejunum, ileum and duodenum were found in modern HY (high-yield) and MP (multipurpose) strains than in slow-growing ACR (Athens Canadian Random Bred) chickens.

Based on a review of the literature on digestive tract morphology and morphometry in birds, Szczepańczyk (1999) found considerable individual variation in digestive tract structure, which is the result of numerous factors. One of the most important is the type and amount of food ingested. Others include body size, species, breed, sex, age, health, and physiological status of the birds. Changes in digestive tract structure mainly concern the weight, length, and width of the different segments.

The aim of the study was to determine body weight and dimensions, body conformation, length of the digestive tract and its segments, as well as their relationships in of intensively-reared broiler chickens of different genetic lines.

MATERIALS AND METHODS

The study was carried out on the experimental farm of the Department of Poultry Breeding, operating as part of the Agricultural Experimental Station, which belongs to the UTP University of Science and Technology in Bydgoszcz, Poland. All procedures were performed in accordance with the Local Ethics Committee in Bydgoszcz (approval number 8 of 2010). Subjects were sixty 42-day-old broiler chickens from three commercial lines (Ross 308, Hubbard Flex, Hubbard F15) obtained from the "Drobex" poultry company based in Solec Kujawski near Bydgoszcz.

Throughout the rearing period, broilers were kept on litter in confinement housing (3 buildings, each having an area of about 1000 m^2) under controlled environment. Stocking density on day 42 (after thinning at 5 weeks) ranged from 27.3 kg/m^2 to 27.6 kg/m^2 (13 birds/m^2). Birds were fed *ad libitum* commercial broiler mash diets: starter 1 from 1 to 7 days (21% crude protein, 3% crude oil and fat, 3.5% crude fiber), starter 2 from 8 days to 21 days (20.5% crude protein, 4% crude oil and fat, 3.5% crude fiber), grower from 22 days to 34 days (19% protein, 6% fat and 3.6% crude fiber), and finisher (18% protein, 7% fat and oil, 3,6% crude fiber) from 35 days of rearing. During the rearing period, Ross 308 and Hubbard Flex chickens were given enrofloxacin (week 1, for 3 days) and doxycyclin (week 4, for 3 days) antibiotics in the drinking water. All flocks received Newcastle disease and Gumboro vaccines in water.

At 42 days of age, 20 birds from each commercial line were randomly chosen (60 in total) and transported to the Department's experimental farm. Prior to slaughter, chickens were measured for body weight to the nearest 0.1 g (Precisa 5/12 electronic scales, Medicat) and for body dimensions. Birds were tape-measured with an accuracy of 1 mm for length of trunk with neck – body length (between the first cervical vertebra and posterior superior tuberosity of the ischium), length of trunk (between tarsal joint and posterior superior tuberosity of the ischium), length of keel (from the anterior to the posterior edge of the keel), chest circumference (behind wings through anterior edge of the keel and middle thoracic vertebra), length of thigh (along the thigh bone) and length of shank (between tarsal joint and posterior area of the fourth toe at its base). Body weight and body measurement values of 42-day-old broilers were used for the calculation of the body conformation indices of massiveness (percentage ratio of body weight in kg to trunk length, in cm), compactness (percentage ratio of chest circumference to trunk length, in cm) and long-leggedness (percentage ratio of shank length to body length, in cm).

Following live evaluation, the birds were slaughtered, defeathered and eviscerated. The digestive tract and internal organs were separated. The length of the esophagus and crop, small intestine, both caeca and large intestine was tape-measured. In addition, the following internal organs were separated and weighed to the nearest 0.001 g on a Medicat M160 scales: gizzard (without digesta), proventriculus (without digesta), liver (without gallbladder), heart, and spleen. Next, the percentage of these organs to preslaughter body weight was determined.

The numerical data were statistically analyzed. Arithmetic means and standard errors (SE for all lines) were calculated for body conformation and internal organs characteristics. The arithmetic means of traits evaluated in the Ross 308, Hubbard Flex and Hubbard F15 chickens were compared by Tukey's pair-wise comparison test. Differences were considered significant at $p \leq 0.05$. Pearson's coefficients of correlation were calculated to determine the relationships between zoometric body measurements. The calculations were made using SAS software (SAS Institute Inc, 2003).

RESULTS AND DISCUSSION

The mean body weight of the evaluated broiler chicken lines, which ranged from 2101.1 g (Ross 308) to 2154.4 g (Hubbard Flex) at 42 days of age, may be indicative of their normal development resulting mainly from appropriate nutrition and environmental conditions of the buildings during the rearing period (Table 1). The similar body weight of the chickens at 42 days of age contributed to the lack of statistically significant differences among the commercial lines under comparison. The body weight of 42-day-old broiler chickens in our study was similar to the findings of Doktor & Połtowicz (2009) and Biesiada-Drzazga *et al.* (2011). When evaluating 11 commercial lines of broiler chickens raised in Poland, Grużewska *et al.* (2008) found lower body weight in 42-day-old Hubbard Flex, Hubbard F15 and Ross 308 chickens compared with our study. However, the broilers evaluated at 42

Table 1 – Body weight and dimensions of broiler chickens.

Genotype	Body weight (g)	Length of (cm)					Chest circumference (cm)
		Trunk and neck	Trunk	Keel	Thigh	Shank	
Ross 308	2101.1	29.5	18.8[a]	13.7	12.9[ab]	10.0	29.7[a]
Hubbard Flex	2154.4	29.5	19.0[a]	13.6	13.3[a]	10.3	29.1[ab]
Hubbard F15	2142.2	30.2	20.0[b]	13.6	12.8[b]	10.4	28.4[b]
Pooled SE	14.3	0.2	0.2	0.1	0.1	0.1	0.2

[a,b]Indicate significant differences among groups ($p \leq 0.05$).

days of age in our study were considerably lighter than Ross 308 chickens of the same age investigated by Murawska *et al.* (2011).

The analysis of body dimensions of the commercial lines of broiler chickens under comparison (Table 1) indicates significant differences in trunk length, thigh length, and chest circumference. Hubbard F15 broilers had significantly ($p \leq 0.05$) greater trunk length compared with Ross 308 and Hubbard Flex, significantly ($p \leq 0.05$) shorter thighs compared with Hubbard Flex, and smaller chest circumference compared with Ross 308 chickens which may be indicative of different selection pressures on parent flocks of the commercial lines under comparison. Udeh & Ogbu (2011) found significant differences among three lines of 56-day-old broiler chickens (Arbor Acre, Marshal and Ross) in terms of body weight, body length, thigh length, drumstick length, breast width and wing length. In a study by Latshaw & Bishop (2001), young Ross and Avian chickens had greater chest circumference and shorter keel compared with the Ross 308, Hubbard Flex and Hubbard F15 chickens analyzed in our study. In another experiment (Udeh & Ogbu, 2011), greater body length was observed in lighter 8-week-old chickens. Greater indices of massiveness and long-leggedness were calculated for Hubbard Flex compared to Ross 308 and Hubbard F15 chickens. Ross 308 chickens were characterized by significantly greater ($p \leq 0.05$) index of compactness compared with Hubbard F15 (Table 2).

Table 2 – Body conformation indices of broiler chickens.

Genotype	Body conformation indices (%)		
	Massiveness	Compactness	Long-leggedness
Ross 308	11.2	158.0[a]	33.9
Hubbard Flex	11.3	153.1[a]	34.9
Hubbard F15	10.7	142.0[b]	34.4
Pooled SE	0.1	2.0	0.4

[a,b]Indicate significant differences among groups ($p \leq 0.05$).

The length of different segments of the digestive tract is presented in Table 3. Esophagus (with crop) was the longest in Hubbard F15 and the shortest in Ross 308 broilers. The difference in esophagus length between these lines was statistically significant ($p \leq 0.05$). The longest total intestine was noted in Ross 308 chickens. The shortest small intestine was found in Hubbard Flex, and the shortest caeca and large intestine in Hubbard F15 chickens. Hubbard F15 had significantly ($p \leq 0.05$) shorter large intestine compared with Ross 308 birds. The differences in the length of intestine and its segments in the evaluated commercial lines of broiler chickens may give rise to differences in nutrient absorption and, in consequence, to differences in the value of their meat traits. In an earlier study, Gabriel *et al.* (2008) observed small intestine was shorter in Ross PM3 males, and Torgowski (1980) found shorter small intestine and large intestine in young chickens compared with the birds analyzed in our study.

Table 3 – Length of digestive tract segments in broiler chickens.

Genotype	Length of (cm)				
	Esophagus	Small intestine	Caeca	Large intestine	Intestine, Total
Ross 308	18.4[a]	198.0	41.1	12.3[a]	251.4
Hubbard Flex	18.8[ab]	183.2	40.2	11.4[ab]	234.8
Hubbard F15	20.6[b]	199.1	40.1	10.2[b]	249.4
Pooled SE	0.4	4.5	0.8	0.3	0.2

[a,b]Indicate significant differences among groups ($p \leq 0.05$).

The genotype of the analyzed chickens had no significant effect on the weight of the main internal organs except for weight proventriculus (Table 4).

Table 4 – Weight of main internal organs in broiler chickens.

Genotype	Weight of (g)				
	Liver	Heart	Proventriculus	Gizzard	Spleen
Ross 308	43.6	9.6	8.3[a]	24.7	2.7
Hubbard Flex	49.9	10.2	8.7[ab]	27.8	2.6
Hubbard F15	42.5	10.3	9.8[b]	26.8	2.3
Pooled SE	2.0	0.2	0.3	1.0	0.1

[a,b]Indicate significant differences among groups ($p \leq 0.05$).

Hubbard F15 chickens had a significantly ($p \leq 0.05$) heavier proventriculus compared to Ross 308 birds. Hubbard Flex had the heaviest liver and gizzard, Hubbard F15 the heaviest heart and proventriculus, and Ross 308 chickens the heaviest spleen. The higher gizzard weight in Hubbard Flex broilers is indicative of its better muscle development, which may have a positive effect on the particle size of digesta and nutrient absorption. Wijtten *et al.* (2010) reported the heart weight was highly significantly (p<0.001) greater in 36-day-old male Ross 308 than in male Cobb 500 chickens of the same age, whereas Makovický *et al.* (2012) found heavier livers in 35-day-old male Ross 308 compared with male Cobb 500 chickens of the same age. The weight of proventriculus in the chickens under analysis was similar to that of 42-day-old Avian chicks investigated by Saki (2005) and 42-day-old Ross 308 chickens studied by Biesiada-Drzazga *et al*. (2011).

The percentage of the main internal organs in the body was similar, with no statistically significant differences (Table 5).

Table 5 – Percentage of main internal organs in the body of broiler chickens.

Genotype	Content in body weight (%)				
	Liver	Heart	Proventriculus	Gizzard	Spleen
Ross 308	2.1	0.46	0.40	1.2	0.13
Hubbard Flex	2.3	0.47	0.40	1.3	0.12
Hubbard F15	2.0	0.48	0.46	1.3	0.11
Pooled SE	0.05	0.01	0.01	0.04	0.003

No statistically significant differences were found.

Ross 308 chickens were characterized by the greatest percentage of spleen, Hubbard Flex by the greatest percentage of liver, and Hubbard F15 by the greatest heart and proventriculus percentages. Ross 308 and Hubbard Flex had the smallest proportion of proventriculus to body weight prior to slaughter. Sharifi *et al.* (2012) found a greater proportion of proventriculus and liver in 45-day-old broiler chickens, and Hernández *et al.* (2004) and Hossain *et al*. (2012) a smaller proportion of proventriculus compared with the birds from our study. Another experiment (Deeb & Lamont, 2002) found a similar proportion of spleen in 56-day-old broiler chickens and a much greater proportion in Leghorn and Fayoumi chickens.

The analysis of the coefficients of correlation between body weight and dimensions, and the length of digestive tract segments showed no statistically significant relationships among the analyzed traits (Table 6).

The Pearson's correlation values were low (below 0.3). The highest positive correlations were estimated between trunk length and length of the esophagus, and the highest negative correlations between trunk length and large intestine length.

The coefficients of correlation were lower than those obtained by Szczepańczyk *et al.* (2000) for the morphometry of the esophagus and gut in bean goose (*Anser fabalis*). In the same study, body weight and body length were significantly correlated (p<0.001) with esophagus length and combined rectum and cloaca length, as well as significant coefficients of correlation were also found between body weight and combined jejunum and ileum length.

CONCLUSIONS

At 42 days of age, Ross 308 chickens had shorter trunk, but greater chest circumference and index of compactness, as well as shorter esophagus and longer large intestine compared with Hubbard F15 chickens. Hubbard Flex chickens had the greatest body weight and longest thighs, whereas Ross 308 the longest large and total intestine. Chicken genotype had no significant effect on the percentage of main internal organs, such as liver, gizzard, heart, spleen, and proventriculus. In the compared commercial lines of broiler chickens, the correlation coefficients between body weight, body dimensions and the length of the esophagus, small intestine, caeca and large intestine were low and not significant.

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Table 6 – Coefficients of correlation between weight and selected dimensions of the body and length of digestive tract segments in broiler chickens.

Trait	Esophagus length (cm)	Small intestine length (cm)	Caeca length (cm)	Large intestine length (cm)
Body weight (g)	0.104	0.009	–0.128	–0.011
Trunk & neck length (cm)	0.147	0.143	–0.186	–0.078
Trunk length (cm)	0.284	0.105	–0.121	–0.279
Keel length (cm)	–0.033	–0.082	–0.152	–0.055
Chest circumference (cm)	0.106	–0.091	–0.038	–0.239

Coefficients of correlation were not statistically different.

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