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Effect of Age and Sex on Digestive Tract Morphometry of Guinea Fowl (*Numida meleagris* L.)

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As guinea fowl age, their body weights and length of the esophagus and crop increased significantly, and relative length (cm × 100 g b.w^{-1}) of the small intestine, caeca and total intestine decreased significantly ($P \leq 0.05$) in males and females. In addition, 52-week-old males had a significantly higher percentage length of rectum and heart weight, and females a significantly higher gizzard weight compared to 13-week-old birds. Compared to females, adult males differed significantly ($P \leq 0.05$) in the length of caeca and also in the proportion of the gizzard, proventriculus, heart and liver in total weight.

Key words: Guinea fowl, age, sex, digestive tract, gizzard, liver, heart.

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The digestive tract of birds develops rapidly. In the embryo, the archenteron begins to form on the second day of incubation. In newly hatched chicks, the digestive tract constitutes almost 25% of the body weight but this proportion decreases rapidly to reach less than 5% in 8-week-old broilers (LARBIER & LECLERCQ 1995).

The digestive tract of developing birds undergoes changes (allometric growth) in weight and length. These changes and their direction are determined by genetic and environmental factors. In relation to body length, the small intestine of birds is much shorter compared to the mammalian intestine. Moreover, the length of the intestine and its segments differs considerably among avian breeds and species according to the type of ingested food. Birds that feed on fruit and insects have shorter intestines than carnivorous birds and seed eaters (LANGENFELD 1992).

In recent years, the development of the digestive tract in young broiler chickens, game pheasants, guinea fowl and geese was studied by AMERAH and RAVINDRAN (2008), GABRIEL *et al*. (2008), KOKOSZYŃSKI *et al.* (2011), MIHAILOV (2006), MIHAILOV *et al*. (2008) and LIU *et al*. (2010), among others. Studies on broiler chickens showed that the relative length of the small intestine (and its segments) and caeca decreased with age (AMERAH & RAVINDRAN 2008; GABRIEL *et al*. 2008). In addition, KOKOSZYŃSKI *et al*. (2011) showed that the relative length of the intestine was significantly greater in female than in male young game pheasants. MIHAILOV *et al*. (2008) reported a 2.8-fold increase in the length of the small intestine of Japanese quail during the first 5 days after hatching. The digestive tract of Japanese quail is already morphologically and functionally mature between 7 and 14 days of age, with subsequent linear changes in the digestive tract of older birds being non-significant.

Studies on guinea fowl have concentrated on the morphometry of internal organs, including the digestive tract, and the effects of origin (OYEWALE 1989), sex (AIRE *et al*. 1980), ration composition (ADEYEMO & OYEJOLA 2004; NAHASHON *et al*. 2005), feeding method (SINGH *et al*. 1989) and season of the year (OGWUEGBU *et al*. 1987). We know of no research comparing the digestive tract and other internal organs in farmed young and adult guinea fowl.

The aim of this study was to determine the effect of age and sex of pearl grey guinea fowl on struc-

ture and length of the digestive tract and on the weight and proportion of some internal organs.

Material and Methods

The study was carried out according to the guidelines of the Ethical Committee in Bydgoszcz (No. 17/2010).

The study was carried out at a poultry farm in Wierzchucinek belonging to the Agricultural Experimental Station Minikowo, which is part of the University of Technology and Life Sciences in Bydgoszcz. The experiment used 60 day-old pearl grey guinea fowl chicks. Throughout the experiment, guinea fowl were kept in confinement in a controlled environment and had no free-range access. Birds were kept without regard to sex in cages (2×1.05 m^2) on wire-mesh floors for the first 3 weeks and later in pens on straw bedding (2 groups with 30 birds per group). During the rearing period, guinea fowl were initially fed commercial diets for fattening turkeys and wheat grain after the period of intensive growth. A commercial diet for laying hens was used during the egg production period. Guinea fowl received a diet containing 24.5% crude protein and 12.15 MJ ME to 3 weeks of age, 22.6% protein and 12.35 MJ ME from 4 to 8 weeks of age, and 20.7% protein and 12.55 MJ ME from 9 to 16 weeks of age. From 17 to 30 weeks, birds were fed wheat grain containing 12.0% protein and 12.85 MJ ME, and from 31 to 52 weeks (prelaying and egg production periods) they received a commercial diet containing 16% protein and 11.45 MJ ME per kg.

At 13 weeks of rearing, 10 guinea fowl (5 males and 5 females) were randomly chosen for slaughter; at 52 weeks 14 birds (7 males and 7 females) were chosen based on secondary sex characters (wattle and/or helmet size). The selected birds were identified with padlock tags (on the wing) and weighed on poultry scales with an accuracy of 20 g. They were tape-measured with an accuracy of 1 mm for body length (trunk with neck), i.e. the distance between the first cervical vertebra and posterior edge of the ischium. Thereafter, birds were slaughtered and eviscerated. Following evisceration, digestive tracts were separated and sex was confirmed based on sexual organs. The length of the small intestine, two caeca and rectum was tape-measured with an accuracy of 1 mm. Total length of the intestine and its segments was converted into 100 g body weight. The percentage of individual intestinal segment length was determined at different ages according to sex. After gutting, the gizzard, proventriculus, liver and heart were separated and weighed, and percentage of these organs in preslaughter body weight was calculated.

The numerical data were analysed statistically to determine arithmetic means (MEAN) and coefficients of variation (CV) for the traits studied. The significance of differences between mean values for guinea fowl of different ages within the same sex and between males and females of the same age were determined using Student's *t*-test. Calculations were made using Statistica software (STATSOFT 2001).

Results and Discussion

The pearl grey guinea fowl were characterized by relatively high body weight at 13 and 52 weeks of age. Body weight increased significantly in males and females with advancing age by 388 g and 476 g, respectively (Table 1). At both evaluation times males were lighter than females, a finding also reported by LETERRIER *et al*. (1999). MAZANOWSKI *et al*. (1982) obtained a similar body weight for 12-week-old guinea fowl (males 1199-1289 g, females 1207-1307 g) to that obtained in our study in 13-week-old birds. Much higher body weights at slaughter age were reported for young slaughter guinea fowl with excellent meat characteristics (LETERRIER *et al*. 1999; BAÉZA *et al*. 2001).

Table 1

Body weight, body and intestine length and their ratio in guinea fowl of different age

Trait		13 weeks		52 weeks	
		males	females	males	females
Body weight (g)	mean	1232[a]	1257[a]	1620[b]	1733[b]
	CV	2.4	1.7	11.0	13.5
Body length (cm)	mean	33.7	34.2	35.0	34.7
	CV	2.5	4.6	3.7	3.8
Intestine length (cm)	mean	128.6	144.1	122.3	133.0
	CV	1.7	3.4	2.2	1.5
Intestine: body length ratio	mean	3.8	4.2	3.5	3.8

a, b – mean values of traits in rows with different letters, separately for males and females, differ significantly ($P \leq 0.05$).

Table 2

Length of segments of the digestive tract in guinea fowl of different age

Trait		13 weeks		52 weeks	
		males	females	males	females
Length (cm)					
Esophagus and crop	mean	20.0[a]	17.7[a]	25.0[b]	24.7[b]
	CV	11.2	5.9	10.3	15.2
Small intestine	mean	89.3	96.7	82.3	88.7
	CV	4.8	13.5	11.8	8.8
Caeca	mean	30.5	36.8[*]	27.5	32.0[*]
	CV	9.3	7.7	11.3	14.5
Rectum	mean	8.8	10.6	12.5	12.3
	CV	21.2	20.0	17.0	18.5

a, b – mean values of traits in rows with different letters, separately for males and females, differ significantly ($P \leq 0.05$).
* – mean values for different sexes of birds of the same age differ significantly.

Compared to females, the analysed males were characterized by lower body length at 13 weeks of age and by higher body length at 52 weeks of age. In 12-week-old guinea fowl weighing 1.11 (earth floor) and 1.29 kg (concrete floor), NSOSO *et al*. (2006) found markedly lower body length (22.79 and 22.61 cm) than in birds investigated in our study.

Total intestine length and the intestine length to body length ratio were greater in females than in males, and in young compared to adult birds (Table 1). In 16-week-old game pheasants, KOKOSZYŃSKI *et al*. (2010) found that total intestine and small intestine length was greater in males than in females.

As is clear from Table 2, there were increases in the length of the esophagus and crop ($P \leq 0.05$) and rectum as guinea fowl became older. In adult guinea fowl slaughtered at 52 weeks, the small intestine and caecum were shorter than in 13-week-old birds. Of the traits under discussion, rectum length was characterized by the highest variation (v>15%). In another experiment (ADEYEMO & OYEJOLA 2004), small intestine length was much greater (123.19-125.22 cm) in 20-week-old guinea fowl compared to the present study. Macroscopic examination of the digestive tract in young and adult game pheasants showed that the length of the digestive tract and different intestinal segments did not differ significantly among birds of different ages and the weight of the digestive tract was markedly higher in adult birds (TORGOWSKI 1980). However, compared to females, adult males had significantly ($P \leq 0.05$) greater weight and length of the digestive tract.

The percentage length of small intestine and caeca decreased, and the proportion of rectum increased with the age in the examined guinea fowl. There were significant differences in rectum length between males (Fig. 1). Adult males and females had significantly shorter (cm × 100 g mc^{-1})

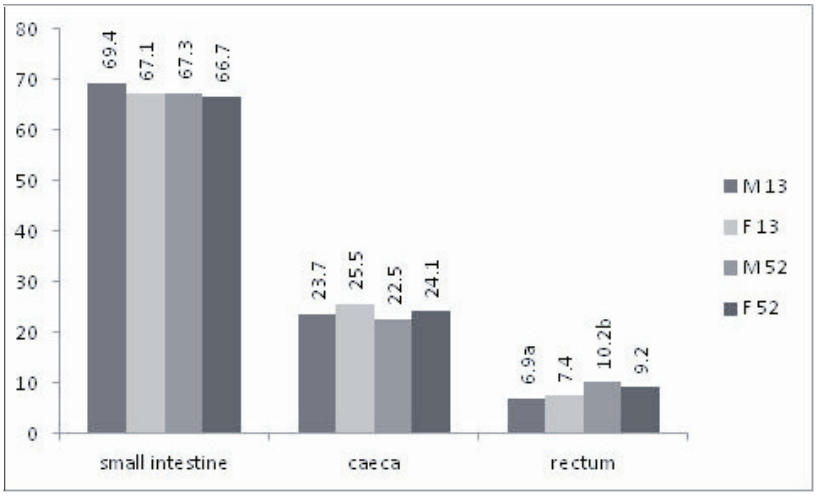

Fig. 1. Percentage length of intestinal segments in males (M) and females (F) aged 13 and 52 weeks. a, b – mean values of traits in rows with different letters, separately in males and females, differ significantly ($P \leq 0.05$).

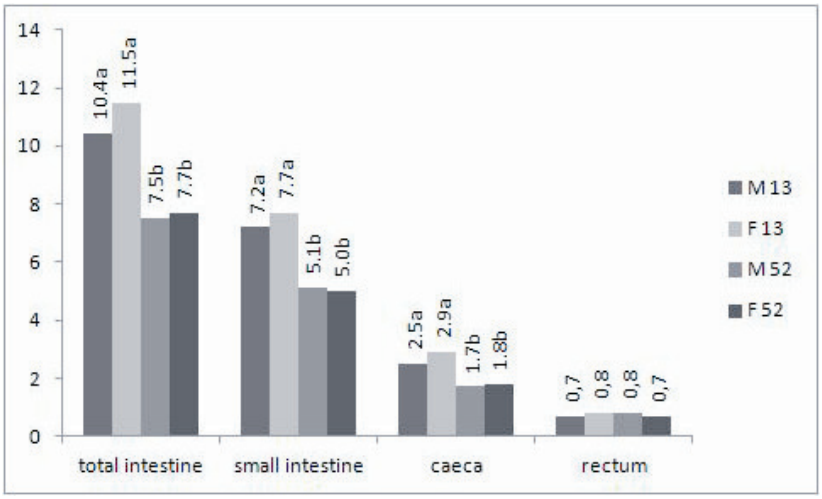

Fig. 2. Relative length of the intestine (cm × 100 g bw $^{-1}$) in males (M) and females (F) aged 13 and 52 weeks.
a, b – mean values of traits in rows with different letters, separately in males and females, differ significantly ($P \leq 0.05$).

Table 3

Weight and proportional weight in total body weight (%) of main internal organs in guinea fowl of different age

Trait		13 weeks		52 weeks	
		males	females	males	females
Weight (g)					
Gizzard	mean	24.1	25.7[a]	29.5	38.9[*b]
	CV	12.7	17.4	16.7	13.1
Proventriculus	mean	4.6	5.1	4.5	6.0[*]
	CV	16.9	18.0	16.5	17.6
Liver	mean	19.9	22.3	19.0	28.7[*]
	CV	10.9	6.7	10.0	24.4
Heart	mean	6.9[a]	6.2	10.5[b]	7.2[*]
	CV	11.7	13.2	15.4	17.1
Proportion in body weight (%)					
Gizzard	mean	2.0	2.0	1.9	2.3*
	CV	11.6	18.2	24.8	19.4
Proventriculus	mean	0.4	0.4	0.3	0.4*
	CV	18.0	17.8	20.7	23.3
Liver	mean	1.6	1.8	1.3	1.7*
	CV	10.6	7.4	15.7	25.5
Heart	mean	0.6	0.5	0.6	0.4*
	CV	11.9	14.3	14.7	18.8

a, b – mean values of traits in rows with different letters, separately for males and females, differ significantly ($P \leq 0.05$).
* – mean values for different sexes of birds of the same age differ significantly.

small intestine, caeca and total intestines (Fig. 2). Compared to 13-week-old birds, adult males aged 52 weeks had heavier gizzards and hearts, while females had heavier also livers and proventriculuses. Significant differences were found for heart weight in males and for gizzard weight in females. Compared to females, males aged 52 weeks had significantly heavier hearts and significantly lighter gizzards, proventriculuses and livers (Table 3). In 8-week-old guinea fowl, NAHASHON *et al.* (2005) found lower gizzard weights (20.1-21.5 g) and liver weights (17.4-18.0 g) but similar heart weights (6.1-6.5 g) compared to guinea fowl examined in our study.

With age, the weight of the gizzard, proventriculus and liver in total body weight decreased in males, and proportional weights of liver and heart decreased in females. Compared to females, 52-week-old

males were characterized by a significantly higher proportion of the heart and lower ($P \leq 0.05$) proportions of the gizzard, proventriculus and liver (Table 3).

In summary, as guinea fowl aged their body weight and length increased and their total intestinal length and intestine to body ratio decreased. In adult birds, the esophagus and crop as well as caeca were longer, whereas the small intestine and rectum were shorter than in young birds. Adult males and females had significantly shorter relative lengths (cm $\times$ 100 g $b.w^{-1}$) of the small intestine, caeca and total intestine. In addition, 52-week-old males had significantly ($P \leq 0.05$) greater weight of the heart and proportion of rectum, and females had significantly greater gizzard weight. The internal organs of adult guinea fowl of different sexes differed in terms of weight and percentage in the body.

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