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The Effect of Using Whole Wheat Grain in the Diet of Game Pheasants on their Body Weight, Dimensions and Development of Some Internal Organs

Dariusz KOKOSZYŃSKI, Zenon BERNACKI, and Agnieszka CISOWSKA

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The supplementation of game pheasant diet from 5 weeks of age with 30% whole wheat grain instead of feed mixture did not significantly affect their body weight nor most body dimensions. Female and male pheasants fed a diet containing wheat grain had smaller body and trunk lengths, greater chest circumference and greater length of breastbone, and lower thigh and shank size. Female pheasants were characterized by higher indices of compactness and long-leggedness, whereas male pheasants had higher indices of massiveness, compactness and long-leggedness than pheasants fed only feed mixtures. Cock pheasants receiving the wheat diet also had a statistically shorter trunk, however, hens possessed a statistically longer lower thigh. Length of intestine (174.2 cm) and individual parts of the intestine (small intestine 119.9 cm; caeca 43 cm; rectum 11.3 cm) was greater in cocks fed whole wheat grain compared to cocks receiving only feed mixtures (156.1; 107.6; 38.8; 9.7 cm, respectively). An opposite cocks was found in hens. Supplementation of whole wheat grain in the diets significantly ($P \leq 0.05$) increased liver weight and percentage in females and significantly decreased testicular weight and percentage in males. It was also found that females of both feed-treatment groups had significantly lower weights of heart, liver and spleen, and hens fed only feed mixtures were also characterized by a significantly lower weight of the proventriculus.

Key words: Pheasant, wheat, body dimensions, intestine, heart, liver.

Dariusz KOKOSZYŃSKI, Zenon BERNACKI, Agnieszka CISOWSKA, Department of Poultry Breeding, Faculty of Animal Breeding and Biology, University of Technology and Life Sciences, Mazowiecka 28, 85-084 Bydgoszcz, Poland
E-mail: kokoszynski@utp.edu.pl

The effect of using whole wheat grain in the diets of broiler chickens and young slaughter turkeys on their weight, carcass composition and meat quality has been the subject of much study in recent years (CHOŁOCIŃSKA & WĘŻYK 1999; MAJEWSKA 1995; KOKOSZYŃSKI *et al*. 2008; KRAWCZYK *et al*. 2002; KUCHARSKI *et al*. 2002; SAGE *et al*. 2002). Other studies investigated the effect of the amount and type of food and poultry feeding system on the length and weight of the digestive tract, its segments, and some internal organs as one of the most important factors of growth in poultry (BORIN *et al*. 2006; CELIK & ACKGOZ 2006; HERNÁNDEZ *et al*. 2004; JØRGENSEN *et al*. 1996; MARZONI *et al*. 2005; STARCK *et al*. 2003; THOMAS *et al*. 2005). It was shown that the structure of individual parts of the digestive tract and weight of major internal organs in birds is largely influenced by species, age, sex, flock size, housing system and ambient temperature (BARTYZEL *et al*. 2005; BORIN *et al*. 2006; CELIK & ACKGOZ 2006; GÓRKA *et al*. 2006; HELL *et al*. 2003; HERNÁNDEZ *et al*. 2004; HAN 2006; FENNA & BOAG 1974; GILLE *et al*. 1999; RICARD & PETITJEAN 1989; TORGOWSKI 1980).

The structure and the weights and lengths of the digestive tract and its segments in pheasants were studied by HAN (2006); MARZONI *et al*. (2005); MEZGER (1984); THOMAS *et al*. (2005); TORGOWSKI (1980), and WANG (1991). Moreover, HELL *et al*. (2003) and RICARD & PETITJEAN (1989) determined the effect of game pheasant housing (living) conditions and sex on the weight of major internal organs (heart, liver, gizzard, spleen and lung).

TORGOWSKI (1980) compared the weight and length of the digestive tract in young and adult game pheasants, chickens and turkeys and found that pheasants were characterized by a lower percentage weight of the digestive tract in relation to body weight, while the length of individual segments, except the caeca, was smaller than in hens and turkeys. JASZCZEWSKA (1969) reported that the caecum of wild pheasants is about 10 cm

longer compared to that of breeding pheasants, which is due to the more diverse and fibrous food consumed by free-living pheasants. Moreover, MARZONI *et al*. (2005) showed no significant effect of feeding hen pheasants diets containing tannin (Quebracho tannin powder at a level of 2%) from 65 to 120 days of age on the length of the small intestine and caeca. However, the use of a tannin (Quebracho) diet caused a significant reduction in liver percentage in pheasant bodies.

Aviary pheasants usually receive pelleted or crumbled feed mixtures that contain all essential nutrients. Breeders often replace part of the mixtures with grain to improve economic results. The aim of this study was to determine the effect of partial replacement of feed mixture with whole wheat grain on body weight and dimensions, length of the digestive tract segments and weights and proportions of major internal organs in game pheasants.

Material and Methods

The study was carried out at the experimental farm of the Department of Poultry Breeding of the University of Technology and Life Sciences in Bydgoszcz, Poland. A total of 80 game pheasants were randomly assigned to two feeding groups with 40 birds per group.

Pheasants were penned in a confinement building to 8 weeks of age, after which they were moved outdoors to separate aviaries. Birds were fed *ad libitum*. All pheasants were fed a diet containing 27.0% crude protein and 11.8 MJ ME to 4 weeks of age. From 5 to 8 weeks of age, control pheasants received a diet containing 23.5% protein and 12.1 MJ energy, and from 9 weeks to the end of the trial a diet containing 17.0% protein and 11.5 MJ metabolizable energy. From 5 weeks of age, experimental pheasants (group B) were fed a diet containing 70% feed mixture and 30% whole wheat grain.

At 16 weeks of age, pheasants were individually weighed using an electronic scale (Medicat) and their body dimensions were determined. They were tape-measured to an accuracy of 1 mm for length of trunk with neck – length of body (between the first cervical vertebra and posterior edge of the ischium), length of trunk (between shoulder joint and posterior edge of the ischium), length of keel (from the anterior to the posterior edge), length of shank (between the hock joint and bottom posterior area of the first toe at its base), length of lower thigh (along the shin bone) and chest circumference (behind wings through anterior edge of the keel and middle thoracic vertebra). Body weight and body dimensions were used to calculate the conformation indices of massiveness (percentage proportion of body weight in kg to trunk length in cm), compactness (percentage proportion of chest circumference to trunk length in cm) and long-leggedness (percentage proportion of shank length to body length in cm).

After the body weight and body dimensions were determined, five males and five females of body weight similar to the average body weight of a given sex were selected from each feeding group. After slaughter and plucking, birds were eviscerated and their digestive tracts were removed. The lengths of the oesophagus and crop, small intestine, both caeca and rectum were tape-measured with an accuracy of 0.1 cm. In addition, liver, empty gizzard, empty proventriculus, heart, spleen and testes were removed and weighed, and their percentages in body weights were determined directly before slaughter.

Means (x) and coefficients of variation (v) were computed for the studied traits. The significance of differences between the feed groups for the analysed traits were determined using Student's *t*-tests (SAS/STAT 1995).

Results and Discussion

The body weight of cock pheasants selected for slaughter at the age of 16 weeks and fed complete diets throughout the study averaged 1220.3 g and was 33.7 g lower than in cocks fed a diet of 70% feed mixture and 30% whole wheat grain from 5 weeks of age. Hen pheasants receiving the feed mixtures were heavier (953.4 g) than hens fed wheat grain (898.5 g). In addition, in both feed groups males had a significantly greater body weight compared to females and showed greater variation (greater v) in the group fed the wheat grain diet. In a study by SAGE *et al*. (2002), 16-week-old male game pheasants in which a high-protein diet was replaced with whole wheat grain from 10 weeks of age, were characterized by greater body weight (males: 1145.6-1198.9 g, females 856.2-946.2 g) than control groups. In 16-week-old game pheasants, ADAMSKI & KUŹNIACKA (2006) found similar or lower body weight in cocks (1198 g) and hens (874 g). Likewise, WOODARD *et al*. (1977) reported lower body weight in male (1035-1128 g) and female (755-836 g) pheasants aged 16 weeks. Moreover, NOWACZEWSKI *et al*. (1999) detected greater body weight in male (1344.2 g) and female (991.7 g) game pheasants aged 16 weeks and kept on a farm.

Analysis of body measurements revealed significantly higher values of all measurements in male compared to female pheasants in both feeding groups, indicative of clear sexual dimorphism in this bird species. The length of the body (trunk with neck) was larger in males and females receiv-

Table 1

Body weight, body dimensions and body conformation indices in 16-week-old game pheasants fed different diets

Trait		Diet – sex			
		Feed mixture		Mixture + wheat grain	
		males	females	males	females
Body weight and dimensions					
Body weight (g)	x	1220.3	953.4*	1254.0	898.5*
	v	8.0	8.7	14.2	10.4
Body length (cm)	x	29.7	27.0*	29.1	26.2*
	v	5.4	7.2	3.3	5.3
Trunk length (cm)	x	19.7 [a]	17.3*	18.6 [b]	16.7*
	v	6.1	10.9	4.0	9.1
Chest circumference (cm)	x	27.8	25.1*	28.4	26.0*
	v	4.6	5.1	4.7	6.0
Breastbone length (cm)	x	11.5	10.4*	12.0	10.7*
	v	5.1	6.9	5.5	8.2
Lower thigh length (cm)	x	12.8	11.7 [a]*	13.3	12.4 [b*]
	v	6.9	7.3	6.0	4.8
Shank length (cm)	x	7.1	6.3*	7.4	6.6*
	v	5.6	6.4	5.0	7.9
Body conformation indices					
Massiveness (%)	x	6.2 [a]	5.6	6.7 [b]	5.4*
	v	7.2	17.0	17.7	10.4
Compactness (%)	x	141.1 [a]	145.1	152.7 [b]	155.7
	v	3.7	10.5	4.9	9.9
Long-leggedness (%)	x	23.9 [a]	23.3 [a]	25.4 [b]	25.2 [b]
	v	5.7	5.4	5.6	9.4

a, b – mean values of traits in rows with different letters separate in males and females differ significantly (P≤0.05).
* – mean values for different sexes of the same feeding group differ significantly (P≤0.05).

Table 2

Length of the intestine and its parts and ratio of intestinal length to body length in 16-week-old game pheasants fed different diets

Trait		Diet – sex			
		Feed mixture		Mixture + wheat grain	
		males	females	males	females
Length (cm)					
Oesophagus and crop	x	20.6	17.6	20.7	17.4
	v	13.7	11.1	20.0	15.8
Small intestine	x	107.6	106.8	119.9	101.0*
	v	8.9	8.4	9.9	3.7
Caecum	x	38.8	35.8	43.0	33.0*
	v	3.7	9.4	9.3	8.2
Rectum	x	9.7	8.8	11.3	8.3*
	v	17.3	19.1	29.7	4.6
Total intestine	x	156.1	151.4	174.2	142.3
	v	4.5	4.0	8.8	7.4
Body	x	28.6	26.1	30.2	26.9
	v	1.9	4.4	4.5	3.2
Length ratio					
Intestine: body	x	5.5	5.8	5.8	5.3
	v	2.3	0.9	1.9	2.3

* – mean values for different sexes of the same feed group differ significantly (P≤0.05).
Differences between means within sex in feed groups were not significant.

ing only feed mixtures compared to birds with diets of 30% whole wheat grain from 5 weeks of age (Table 1). Control males and females receiving feed mixture were also characterized by longer trunks compared to experimental birds that received feed mixture plus wheat. In males, this difference was statistically significant. Greater or similar trunk lengths in 16-week-old game pheasants (males 19.5; females 17.5 cm) were reported by WINNICKA (1970). Greater chest circumference in cock and hen pheasants fed wheat grain probably shows that this group is characterized by better development of the digestive tract and internal organs. In addition, males and females receiving whole wheat grain possessed a longer keel compared to those receiving only the feed mixture. WINNICKA (1970) reported that 16-week-old pheasants had shorter keels (males 10.91 cm, females 9.70 cm) but greater chest circumferences (males 29.0 cm, females 28.1 cm). The length of the lower thigh in cocks was 0.5 cm smaller in the control group (12.8 cm) compared to the experimental group (13.3 cm), and in females this value was significantly greater in the experimental group (12.4 cm) compared to the control group (11.7 cm). The length of the shank was greater in birds fed a wheat grain diet. Mean shank lengths in both groups were smaller than in 16-week-old pheasants (males 8.26, females 7.36 cm) studied by WINNICKA (1970).

Table 1 shows that male game pheasants receiving only feed mixtures have significantly lower body conformation indices compared to birds fed wheat grain. Hens fed diets with whole wheat grain were characterized by higher indices of compactness and long-leggedness and lower indices of massiveness compared to females receiving only feed mixtures.

The length of the digestive tract and its segments was greater in 16-week-old cock pheasants fed wheat grain compared to cocks receiving feed mixtures only. In hens, greater lengths of digestive tract segments were found in the group receiving feed mixtures. In addition, male pheasant fed a diet

Table 3

Weight and proportion of major internal organs in 16-week-old game pheasants fed different diets

Trait		Diet – sex			
		Feed mixture		Mixture + wheat grain	
		males	females	males	females
Weight (g)					
Gizzard	x	20.1	16.4	18.3	16.1
	v	18.0	8.0	24.0	14.7
Proventriculus	x	4.6	3.7*	4.4	3.9
	v	9.4	20.8	14.4	12.2
Liver	x	22.5	15.2 [a]*	24.2	19.2 [b]*
	v	18.9	7.7	8.7	6.9
Heart	x	6.5	4.1*	6.3	4.5*
	v	1.2	9.0	5.3	10.8
Spleen	x	1.2	0.8*	1.4	0.8*
	v	19.8	16.7	6.9	18.2
Testes	x	1.0 [a]	–	0.3 [b]	–
	v	78.5	–	26.6	–
Proportion in body weight (%)					
Gizzard	x	1.6	1.7	1.5	1.8
	v	17.3	9.0	9.0	21.6
Proventriculus	x	0.4	0.4	0.4	0.4
	v	8.0	20.8	14.4	9.2
Liver	x	1.8	1.6 [a]	1.9	2.1 [b*]
	v	19.2	7.9	24.2	14.2
Heart	x	0.5	0.4	0.5	0.5
	v	11.0	8.7	6.1	9.1
Spleen	x	0.1	0.1	0.1	0.1
	v	10.8	16.7	70.3	17.8
Testes	X	0.1 [a]	–	0.02 [b]	–
	v	79.1	–	26.0	–

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

of fed mixture and whole wheat grain had a significantly longer small intestine, rectum and caeca compared to female pheasant. In adult pheasants, TORGOWSKI (1980) found smaller (separate male and female) lengths of the small intestine (males 92.4; females 85.6 cm), caeca (males 33.3 cm; females 29.9 cm), and rectum (males 8.6; females 7.9 cm). In 120-day-old female Mongolian pheasants, MARZONI *et al*. (2005) reported that the length of the small intestine was 107.4 cm and that of caeca was 39.8 cm (control group). Total intestinal length in male and female game pheasants of both groups was greater than in the adult pheasants (males 152.7 cm; females 129.1 cm) investigated by TORGOWSKI (1980) – compared to this same sex. Other authors (SAVORY & GENTLE 1976; STARCK *et al*. 2003) found intestinal length to increase when a high-fibre diet was used. In our experiment, the ratios of intestinal length to body length in cock pheasants receiving feed mixtures and fed wheat grain were greater, and those of hens smaller, compared to birds that received feed mixtures alone.

Cock pheasants that received a wheat grain diet had smaller gizzards, proventriculuses, hearts, and testes (significantly), but larger livers and spleens. Hens (feed mixture plus wheat grain) had larger proventriculuses, livers (significantly) and hearts. In addition, sex had a significant effect on the weights of selected internal organs. Compared to hens, cocks had a significantly larger livers, hearts and spleens, and those from the group receiving feed mixture also possessed significantly larger proventriculuses. In 18-week-old breeding pheasants, RICARD & PETITJEAN (1989) found similar weights of gizzards (males 19.2-19.3, females 15.5 g) and livers (males 21.3-21.6 g, females 15.7 g), and larger hearts (males 7.5-7.9 g, females 4.6 g). Other studies (STRAKOVÁ *et al.* 2005) detected larger hearts (males 8.25 g, females 5.58 g) in younger and lighter pheasants compared to birds evaluated in our study. Replacing part of the complete diet (30%) with whole wheat grain increased the percentage of liver in male and female game pheasants (significantly in females). Males fed a diet containing wheat grain were characterized by a smaller proportion of gizzard and especially testes in the body, whereas hens had a greater proportion of gizzard and heart compared to birds receiving only feed mixtures.

In summary, the use of a wheat grain diet increased chest circumference, the length of the breastbone, lower thigh and shanks in pheasants. Males and females fed a diet with extra wheat were characterized by significantly greater indices of long-leggedness, and males also had greater indices of massiveness and compactness. Male game pheasants that also received whole wheat grain had significantly lower weight and percentage of testes, and hens had significantly greater weight and proportion of liver in the body.

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