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SKELETAL DEVELOPMENT OF OUTDOOR REARED ZAGORJE TURKEY FED LOWER PROTEIN DIETS

Krešimir SALAJPAL [1], Zlatko JANJEČIĆ [2], Marija ĐIKIĆ [1], Stjepan MUŽIC [2], Danijel KAROLYI [1], Marina MOROVIĆ [1], Jasna RIBARIĆ [3]

ABSTRACT

The study was carried out on 272 Zagorje turkey chicks to estimate the effect of two different protein levels in diets on growth, bone development and carcass composition at the final age of 24 weeks. Birds of both sexes were divided into two groups: high protein (HP) and low protein group (LP) with 136 animals in each (68 ♂ and 68 ♀). LP group was fed a diet with 4% less crude protein content than the HP group during the first 8 weeks of age, while after this period both group were fed the same diet with access to a fenced pasture of 0.5 ha/group. Higher protein content in early rearing period had a positive effect on final body weight at 24 weeks of age. In the same time, morphometric characteristics of main bones showed that male turkeys of HP group had the most developed skeletal system and consequently the highest carcass weight. The carcass weight in male of HP group was higher than 3.0–3.5 kg as a preferable weight of processed carcasses of Zagorje turkey by Croatian consumers. These suggest that lowering the growth intensity by protein undernutrition during the first 8 weeks could have beneficial effects on carcass market of Zagorje turkey.

Key words: turkeys / Zagorje turkey / animal nutrition / protein level / bone characteristics / carcass composition / Croatia

1 INTRODUCTION

Zagorje Turkey breed is primitive turkey breed widespread primary in North West part of Croatia known as Zagorje region. As a local breed it become more popular in the past ten years due to higher interest of consumers to turkey meat produced in outdoor systems respecting high standards of welfare and traditional technology using local breeds. In comparison to high production hybrids, production results of Zagorje turkey are poorer but beneficial effects are achieved through lower investment in outdoor production and higher market price which can be twice higher than turkey meat from conventional production. Traditionally, rearing takes 6 to 8 months in outdoor production system. It include keeping the turkey chicks under semi-controlled condition in the early rearing period (first 6–8 weeks) and using meadows, orchards, groves or other habitats rich in vegetation and fauna in late finishing period (last 16–20 weeks; Mužic and Janječić, 2002). At the end of this period carcasses reach the weight between 2.5 to 3.5 kg and meat takes specific taste which makes it well accepted among consumers in Croatia. There is not data about nutritional requirements of Zagorje turkey to energy and protein content in diets used in traditional rearing technology. Therefore, in this study was tested effect of two different protein levels in diets used in first 8 weeks of age (equal and 4% lower than NRC recommendation) on bones growth, final weight and carcass composition.

1 Fac. of Agriculture Univ. of Zagreb, Dept. of Animal Science, Svetosimunska c. 25, 10000 Zagreb, Croatia
2 Fac. of Agriculture Univ. of Zagreb, Dept. of Animal Nutrition and Husbandry, Svetosimunska c. 25, 10000 Zagreb, Croatia
3 Ministry of Agriculture, Veterinary Directorate, Planinska 2a, 10 000 Zagreb, Croatia

2 MATERIAL AND METHODS

2.1 THE BIRDS AND REARING MANAGEMENT

In total 272 one day old turkey chicks of Zagorje turkey breed were used in this experiment. The turkey chicks were produced by registered producer from Zagorje region in Croatia. At the beginning of the experiment turkey chicks were divided into two groups: high protein (HP) and low protein group (LP) with 136 animals of both sex in each (68 ♂ and 68 ♀). A 24 weeks experimental period was carried out in two phases. First phase was from 1st to 8th week of age in which turkey chicks were kept under controlled microclimatic conditions. In this period turkey chicks fed starter from 0 to 4 and grower from 5 to 8 week of age. The protein content of starter and grower in HP group was in accordance with NRC recommendation and 4% higher than in LP group (Table 1). In the second phase turkey chicks were replaced outdoor where they have access to a fenced natural pasture of 0.5 ha per group and shed of 6 m^2 connected to a poultry house with 0.5 m^2 of littered floor per bird. From week 9 to 24 both groups were fed the diet containing the same crude protein level. Besides, turkeys had access to green fodder on the natural pasture. Feed and water were given to the birds both outside and inside of poultry house. Diets composition and nutritive value of diets are given in Table 2.

Table 1: *Feeding plan (% of crude protein in diet) in the experimental period*

	Age of birds (in weeks)		
	0–4	5–8	9–24
Group	% of crude protein in diet		
High Protein (HP)	28	24	20
Low Protein (LP)	24	20	20

Table 2: *Diets composition and their nutritive value*

Feed	0–4 week (starter)	5–8 week (grower)	9–24 week (finisher)
Maize	40.50	46.00	53.55
Soybean meal (44%)	36.00	31.00	25.00
Alfaalfa flour	-	3.00	5.00
Tosted soybean	12.00	12.00	10.00
Fish meal	7.00	3.30	1.00
Limestone	2.00	2.00	2.00
Mono-CaP	1.40	1.60	2.00
NaCl	0.40	0.40	0.45
Methionine	0.20	0.20	0.25
VAM*	0.50	0.50	0.50
Total	100.00	100.00	100.00
Nutritive value (calculated)			
Metabolizable energy MJ/kg	11.23	11.13	11.21
Crude protein	28.10	24.22	20.46
Lysine	1.74	1.43	1.33
Methionine+cystine	0.94	0.82	0.76
Tryptophane	0.34	0.29	0.24
Threonine	1.02	0.87	0.72
Ca	1.36	1.35	1.37
P total	0.96	0.92	0.92
P available	0.51	0.50	0.52
Ca/P	1.43	1.47	1.49
Mg	0.15	0.15	0.14

*Vitamin-mineral premix

2.2 CARCASS COMPOSITION AND MORPHOMETRIC CHARACTERISTICS OF BONES

At the end of experimental period live body weight (LW) and carcass weight after slaughter were recorded individually. Twenty birds (10 ♂ and 10 ♀) from each group were randomly selected and dissected by methods of Hahn and Spindler (2002) in main parts: breast with bone and skin, breast muscle (fillet), thigh, drumstick, loin, wing and abdominal fat. The dressing percentage and share (%) of each part in the carcass were calculated.

From the same carcasses bones *femoris, humerus* and *sternum* were removed from the skeleton and trimmed from muscle, tendon and ligaments. The joint cartilages were not removed from the bones. The morphometric characteristics of *os femoris, os humerus* and *sternum* were measured using modified method by von den Driesch (1976). The measures were done by scale, calliper and measuring tape. The following measure were taken: the greatest length (GL) of *femoris*

Table 3: *Effect of protein level in feed on carcass compositions of Zagorje turkey breed (LSM)*

Characteristic		Male		Female		SE
		High protein (n = 10)	Low protein (n = 10)	High protein (n = 10)	Low protein (n = 10)	
Live weight	kg	6.85 [a]	4.70 [b]	4.65 [b]	3.78 [c]	0.06
Carcass weight	kg	4.61 [a]	3.16 [b]	3.10 [b]	2.53 [c]	0.04
Dressing	%	67.26	67.24	66.73	67.02	0.86
Breast with bones and skin	%	33.26 [a]	31.09 [b]	31.82	31.82	0.5
Breast muscle	%	23.44	23.52	23.87	23.70	0.41
Thigh	%	15.88 [a]	16.29	16.88 [b]	16.40	0.22
Drumstick	%	13.03	12.9	13.23	12.78	0.21
Wing	%	13.26 [a]	14.64 [b]	13.97 [a]	14.78 [b]	0.30
Loin	%	22.50	23.06	22.41	22.35	0.37
Abdominal fat	%	1.78 [a]	2.92 [b]	2.41	2.32	0.24

[a, b] – Least squares means (LSM) with different superscript letters in the same row are significantly different (P < 0.01)

and *humerus* as a distance from the most distal point of the *epiphysis distalis* to the most proximal point of the *trochanter major* on *os femoris* or *tuberculum majus* on *os humerus*; medial length (LM) of *femoris* as a distance from the most distal point of *condylus medialis* to the most proximal point of the *caput femoris*; breadth of proximal end (BP) of *femoris* and *humerus* as a distance between the most lateral point on *caput femoris* and *trocheanter major* and *tuberculum majus* and *tuberculum minus*, respectively; breadth of distal end (BD) of *femoris* and *humerus* as a distance between the most lateral point on *condylus lateralis* and *condylus medialis* and distance between most lateral point on *epicondylus lateralis* and *epicondylus medialis,* respectively; diameter (SC) and circumference (CC) of *corpus osis femoris* and *humerus* were measured on the most thickness place of the *diaphisis*; deep of distal end (DD) of *os femoris* and *humerus* as distance from the most cranial to the most caudal point on *epiphysis distalis*. On the *sternum* were measured length (LM) as a distance between from the cranial point of the *manubrium sterni* to the caudal border of the *metasternum* in medial plane; length of the *crista sterni* (LC) as a distance between from the *apex cristae sterni* to the caudal border of the *metasternum*; breadth of *sternal* "wing" (DL) and distance from the "wing" to *cristae sterni*.

Statistical analysis was taken using SAS statistical package. The effect of protein level and sex on live body weight, carcass traits and morphopmetric characteristics of main bones as well their interaction were tested by analysis of variance using PROC GLM. Effects were considered significant if P < 0.05.

3 RESULTS AND DISCUSSION

In the past few years, in Croatia exist projects of preserving, recovering and widespreding the population of Zagorje turkeys as an autochthonous Croatian breed. At the same time there is a growing interest in consuming alternative kind of meat as well as turkey meat from local or «homeland» Zagorje turkey reared in outdoor production system according to traditional technology. One of the most important parts of this technology is free range keeping of birds on pasture during the last 16 to 20 weeks of finishing period (summer and autumn). In this period birds reach a weight of 2 to 4 kg which is usually preferred by Croatian consumers. It is, therefore, interesting to see how different protein levels in starter and grower diets influence the final body weight and their skeletal growth and carcass composition in Zagorje turkey kept outdoor in finishing period. As shown in Table 3, average body weight and carcass weight in HP group were higher than in LP group in both sexes. Similar to our results, in previous studies (Nixey and Grey, 1989; Revington and Moran, 1990; Kidd *et al*., 1997) were reported strong negative effect of protein undernutrition on productive performance in modern heavy turkeys hybrid lines. On the other hand, Auckland *et al*. (1969) examined the effect of undernutrition of turkeys during the period up to 6 weeks of age on the finishing body weights at 20 weeks. The authors established that the effect of undernutrition on the body weight during the first 6 weeks completely disappears at the age of 20 weeks.

As could be expected, male turkeys had a higher final body weight and carcass weight than female in both LP and HP groups. These results are similar to previous results on Zagorje turkey (Kodinetz, 1940; Mužic *et al.,*

Table 4: *Effect of different protein level in feed on morphometric characteristics (LSM) of os femoris at Zagorje turkey*

Characteristic			Male		Female		SE
			High protein (n = 10)	Low protein (n = 10)	High protein (n = 10)	Low protein (n = 10)	
Weight	(W)	g	27.02 [a]	14.6 [b]	15.35 [b]	13.58 [b]	(0.88)
Greatest length	(GL)	mm	125.04 [a]	108.71 [b]	108.43 [b]	102.6 [b]	(2.01)
Medial length	(LM)	mm	113.37 [a]	94.89 [b]	96.00 [b]	92.63 [b]	(1.14)
Smallest breadth of corpus	(SC)	mm	12.30 [a]	10.24 [b]	10.75 [b]	10.85 [b]	(0.28)
Breadth of proximal end	(BP)	mm	32.61 [a]	26.7 [b]	26.26 [b]	25.7 [b]	(0.74)
Deep of proximal end	(DP)	mm	20.23	17.77	19.43	16.87	(0.76)
Breadth of distal end	(BD)	mm	29.12 [a]	23.44 [b]	23.49 [b]	22.23 [b]	(0.44)
Deep of distal end	(DD)	mm	22.66 [a]	18.44 [b]	19.09 [b]	17.51 [b]	(0.45)

[a, b] – Least squares means (LSM) with different superscript letters in the same row are significantly different ($P < 0.01$)

1999; Janječić, 2002) as well in turkeys from Dalmatian hinterland (Ekert Kabalin *et al.*, 2011). The difference between male and female in live and carcass weight in Zagorje turkey were smaller than in modern hybrids such as BUT Big 6 or Nicholas (1.3–1.5 vs. >2.0; Orbanić, 1994; Kidd *et al.*, 1997; Andrassy-Baka *et al.*, 2003). With the average body weight of 6.85 kg and carcass weight of 4.61 kg, male turkeys from HP group are beyond the favourable weight class for Croatian customers (3.0–3.5 kg). Male from LP group as well female from both protein groups are within the preferable weight class for Croatian customers. In the same time, there was no difference in dressing percentage between groups. This suggests that protein undernutrition of male Zagorje turkey in early rearing period could have beneficial effect on their market. In addition, slower growing (lighter) turkey does not give less valuable product for consumers. The average dressing percentage observed in this study was slightly lower than in the previous study conducted under similar experimental condition (67% vs. 69–70%; Janječić, 2002) or similar as in wild turkey (67.9%; Večerek *et al.*, 2008). The share of breast muscle, drumstick and loin in the carcass was not affected by protein level nor by sex. The percentage of wing in HP group was lower than in LP group ($P < 0.01$). In addition, the male turkey in HP group had lower percentage of thigh in the carcass than female ($P < 0.01$). In comparison to commercial hybrids, Zagorje turkey had a less favourable carcass composition (smaller share of breast, thigh and drumstick as well lower dressing percentage). The difference is even more evident in share of breast muscle, 23% in Zagorje turkey in relation to 29% in Nicolas hybrid (Orbanić, 1994). Similar result was observed by Herendy *et al.* (2003) which reported 13–18% higher dressing percentage and 10% higher share of breast in commercial hybrid BUT than in bourbon turkey reared in extensive system. In previous studies on chickens (Leterrier and Nys, 1992) and pigs (Liu *et al.*,1999) were reported that bone traits such as weight, diameter or bone-bending resistance of long bones (*femoris, tibia*) may be associated with growth rate and body weight and indirectly determined by protein level in diet. Weight and some mor-

Table 5: *Effect of different protein level in feed on morphometric characteristics (LSM) of os humerus at Zagorje turkey (LSM)*

Characteristic			Male		Female		SE
			High protein (n = 10)	Low protein (n = 10)	High protein (n = 10)	Low protein (n = 10)	
Weight	(W)	g	17.94 [a]	11.51 [b]	11.25 [b]	10.22 [b]	0.80
Greatest length	(GL)	mm	140.11 [a]	113.99 [b]	114.0 [b]	110.01 [b]	2.04
Smallest breadth of corpus	(SC)	mm	12.24 [a]	10.19 [b]	9.82 [b]	10.16 [b]	0.48
Breadth of proximal end	(BP)	mm	39.94 [a]	33.26 [b]	32.66 [b]	32.14 [b]	0.72
Deep of proximal end	(DP)	mm	22.78 [a]	18.03 [b]	18.99 [b]	17.72 [b]	0.80
Breadth of distal end	(BD)	mm	29.89 [a]	24.59 [b]	25.05 [b]	24.07 [b]	0.50
Deep of distal end	(DD)	mm	16.39 [a]	13.18 [b]	13.43 [b]	13.94 [b]	0.51

[a, b] – Least squares means (LSM) with different superscript letters in the same row are significantly different ($P < 0.05$)

Table 6: *Effect of different protein level in feed on morphometric characteristics (LSM) of os sternum at Zagorje turkey (LSM)*

			Male		Female		
Characteristic			High protein (n = 10)	Low protein (n = 10)	High protein (n = 10)	Low protein (n = 10)	SE
Weight	(W)	g	32.71 [a]	18.75 [b]	20.74 [b]	17.86 [b]	0.81
Length	(LM)	mm	189.3 [a]	158.3 [b]	160.91 [b]	157.68 [b]	2.20
Lenght of *crista sterni*	(LC)	mm	141.0 [a]	119.08 [b]	122.2 [b]	116.54 [b]	2.01
Breadth „wing" of *sternum*	(DL)	mm	67.49 [a]	54.10 [b]	54.58 [b]	53.13 [b]	1.02
distance from „wing" to *crista sterni*	(UL)	mm	89.28 [a]	72.94 [b]	75.45 [b]	71.49 [b]	1.91

[a, b] – Least squares means (LSM) with different superscript letters in the same row are significantly different ($P < 0.01$)

phometric characteristics of main long bones (*femoris* and *humerus*) as well *sternum* in Zagorje turkey fed different protein level in feed is shown in Table 4, 5 and 6.

As could be seen in table 4, 5 and 6, the weight and all measured morphometric traits of bones were higher in male than in female in HP but not in LP group. The differences in weight of both *femoris* and *humerus* primary come out of higher breadth of their proximal and distal end. The male Zagorje turkey in HP group had about 15 to 20% higher breadth of *epiphysis* on *femoris* and *humerus* in comparison to female or turkeys in LP group, while these differences were smaller for other measures (10–15%). Similar trends were observed on *sternum*. The heavier *sternum* and higher length and breadth of *sternum* "wing" were observed in male turkey of HP group in comparison to female or turkey in LP groups ($P < 0.01$). The trends to smallest value of all morphometric traits were observed in female turkeys of LP group ($P < 0.20$).

4 CONLUSIONS

Higher protein content in starter and grower period had a positive effect on final weight in Zagorje turkey at 24 weeks of age. In the same time, morphometric characteristics of main bones showed that male turkeys of HP group had the most developed skeletal system and consequently the highest carcass weight. The carcass weight in male of HP group was higher than 3.0–3.5 kg as a preferable weight of processed carcasses of Zagorje turkey by Croatian consumers. These suggest that lowering the growth intensity by protein undernutrition during the first 8 weeks could have beneficial effects on carcass market of Zagorje turkey.

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