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Quality Parameters of the Tibiae and Femora of Ostriches

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ABSTRACT

An experiment was carried out to establish mean bone quality values of the tibiae and femora of ostriches and to evaluate these bones. The right leg bones of 10 males and 10 female African Black ostriches were evaluated. Birds were radiographed immediately after slaughter (during bleeding), with the aid of a portable X-ray apparatus. The obtained radiographs were scanned and bone mineral density means were obtained using software. Bone strength, Seedor index, and dry matter percentage were evaluated and correlated to weight gain during the finishing period (3-13 months of age). Mean values of the evaluated bone quality traits, not previously found in literature, were established. There were no significant differences between males and females in performance or bone quality parameters. It was concluded that male and female ostriches present similar performance and bone quality at slaughter age.

INTRODUCTION

Bone mineral density is one of the most important parameters to be measured when evaluating bone quality. Bones have a crucial role in normal growth and development of vertebrates. The continuous accretion of cartilage and its subsequent replacement by bone are the main events of the bone elongation process (Howlet, 1980; Banks, 1991; Thorp, 1992; Almeida Paz *et al*., 2005). The study of bone mineral density in commercial poultry by radiographic optical densitometry using the Cromox® Athena-SAI software is very important for poultry production as this modern technique allows the follow-up of bone mass variation at low cost, providing better understanding and assessment of the bone mineralization process (Louzada, 1994). Bone mineral density can also be measured using other techniques, such as bone mineral composition, bone breaking strength, Seedor index (Seedor, 1995), etc. (Orban *et al*., 1983).

In ostriches, muscle and skeleton pathologies are related to different causes, particularly to the lack of exercise in young birds, deficient feeding, rearing on inadequate floors, fast weight gain supported by a still developing skeleton, and genetics (Carrer & Kornfeld, 1999). Leg problems in ostrich chicks may cause considerable mortality (about 5%). In most instances, this is due to improper bird density and inadequate feeding, leading to significant problems and reduced productivity, rendering operations economically unfeasible (Lima, 2005).

The aim of the present study was to establish mean bone quality values of the tibiae and femora of ostriches, and to verify of bird performance influences the quality of these bones.

MATERIAL AND METHODS

Radiograph image collections were carried out in a commercial

processing plant to determine the bone mineral density of tibiae and femora of male and females African Black ostriches.

Birds derived from the same flock, and were all slaughtered on the same day. Ten males and 10 females were radiographed immediately after slaughter (during bleeding), with the aid of a portable X-ray apparatus. After deboning, the bones of these birds were collected and were evaluated as to bone strength, Seedor index, and dry matter content. The values obtained were associated to weight gain during the finishing phase.

Birds were raised as a straight-run flock of 30 individuals - 17 males and 13 females. The flock was established when birds were 3 months, and birds were slaughtered at approximately 13 months of age, or when the flock's average weight was 100kg. The analyzed performance parameters were: initial weight, weight gain, final weight, and mortality, according to the methodology described by Mendes (1990).

During rearing, birds were submitted to typical farm management. Pelleted feed was supplied three times daily, and water was available ad libitum. The flock was reared in a 600-m² paddock with Brachiaria decumbens. Table 1 shows the nutritional values of the feeds supplied.

Table 1 - Nutritional values of the feed supplied to the studied ostriches.

Ingredients	%
Ground corn	44.00
Soybean meal	24.00
Wheat midds	16.00
Ground sorghum	10.97
Calcitic limestone	1.00
Dicalcium phosphate	1.82
Dl - Methionine	0.17
L- Lysine	0.21
Salt	0.33
Vitamin and mineral premix	1.50
Total	**100.00**
Dry matter (%)	88.09
Crude protein (%)	17.47
Metabolizable energy (kcal/kg)	2600
Ether extract (%)	4.21
Total mineral content (%)	7.28
Calcium (%)	0.93
Phosphorus (%)	0.46
Crude fiber (%)	7.93
Non-nitrogen extract	63.11
Total digestible nitrogen	74.30

Vitamin and mineral premix (enrichment/kg feed): vitamin A=24000UI; vitamin D=7000UI; vitamin E=80mg; vitamin K=3,76mg; vitamin B1=1,8mg; vitamin B2=7,7mg; vitamin B6=1,65mg; vitamin B12=40mcg; vitamin C=125mg; pantothenic acid=9,2mg; niacin=40mg; folic acid=1mg; antioxidant=50g; choline=300mg; biotin=0,2mg; selenium=0,27mg; manganese=160mg; iron=76mg; copper=16mg; iodine=2mg; zinc=120mg; cobalt=0,86mg; chromium=0,02mg.

The ostriches were radiographed immediately after slaughter.

The standardized region for reading was the proximal epiphysis of the right tibia and the distal epiphysis of the right femur. The radiograph technique used was 65kVp x 3mAs, with a 90-cm clearance between the focus and the film. Routine clinical radiological procedures were applied, and the developing and fixing processes were carried out in a standard automatic processor. All radiographic films were of the same brand and batch, with green background, equipped with rare-earth screens and 24cm x 30cm frames. The used phantom (aluminum scale with pre-defined density, used as densitometric reference) was that commonly adopted for densitometry readings in horses, consisting of 25 steps, starting at 0.5mm thickness, and increasing every 0.5mm up to the 25th step. Figures 1 and 2 show procedures used for reading ostrich tibiae and femora mineral density.

Figure 1 - Radiographic image used to read bone mineral density.

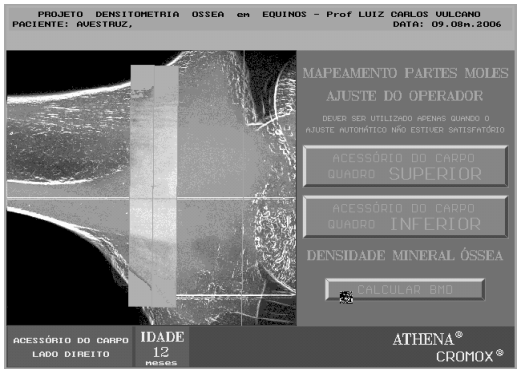

Figure 2 - Frozen image used for limit determination and tibia BMD reading.

Bone specimens were obtained after muscle removal with the aid of a knife and a scalpel 24 hours after slaughter.

Bone strength analyses were carried out at the Department of Rural Engineering of the School of Agronomic Sciences of UNESP, Botucatu campus, Brazil. An EMIC DL 10000 apparatus was used, regulated to allow a 10-cm diaphysis clearance. This was the maximum clearance obtained for the smallest collected bone, and therefore this clearance was used to the remaining bones. Bone strength values were expressed in kilograms-force.

Seedor indexes were obtained by dividing bone weight by its length, as proposed by Seedor (1995). Bones were measured at their longest length, and were weighed using a semi-analytic digital scale with 0.01g accuracy. The Seedor index is an indication of bone density: the higher the value, the denser the bone.

After being submitted to bone strength analysis, bones were taken to the Food Chemical Analyses lab of FMVZ. Dry matter percentage was determined as follows: bones were weighed in an analytical scale, dried in a forced-ventilation oven at 60°C for 72h, after which they were removed from the oven and placed in dessicators until reaching room temperature, and weighed again. Dry matter content was calculated as fresh bone weight minus dried bone weight, and expressed as percentage, according to the method described by Kim *et al*. (2004).

Results were submitted to analysis of variance using SAEG (1998) statistical package at 5% significance level. Means were compared by Tukey's test. Correlations between bone quality and performance parameters were tested using Pearson' test (Gomes, 1982), not taking sex into accounts.

RESULTS AND DISCUSSION

The performance results of the studied flock are presented in Table 2.

There was no difference ($p>0.05$) between males and females for the evaluated performance parameters. Although male weight was higher than that of females, it was not statistically different. The values obtained for all parameters are consistent with those found in literature (Carrer & Kornfeld, 1999; Carvalho, 2006).

Table 3 shows the mean values of bone quality parameters of the tibiae and femora of male and female ostriches. There was no difference ($p>0.05$) between females and males. This indicated that, when reared under the same conditions up to slaughter, bone quality is not different between male and females ostriches, allowing similar performance improvement as their skeletal systems present the same behavior. In broilers and broiler female breeders, fast weight gain may cause locomotion problems, particularly in males (Macari *et al*., 2001; Almeida Paz & Bruno, 2006).

Table 4 presents Pearson's correlations ($p<0.05$) between live weight, weight gain, and bone quality parameters in the ostriches. Tibia and femur quality traits presented significant correlations, particularly bone mineral density and dry matter. Weight gain was correlated only to live weight. These results suggest that only live weight influenced the evaluated bone quality traits. It was observed that the correlation between bone quality and live weight was more notable for the tibia as compared to the femur, probably because the tibia is a fast-growing bone, and growth rate is influenced by the bird's live weight (Thorp, 1992). BMD and Seedor index of the studied

Table 2 - Ostrich performance.

Sex	Av. initial weight (kg)	Av. final weight (kg)	Weight gain (kg)	Mortality (%)
Male	19.53	102.80	83.27	13.33
Female	18.99	90.13	71.14	6.67
Mean	19.26 ± 0.36	96.47 ± 0.28	77.21 ± 0.43	10.00 ± 0.33
Coefficient of variation	2.09	6.98	3.40	3.35

Table 3 - Mean values of bone mineral density (BMD), bone strength (BS), Seedor index (SI) and dry matter content (DM) of the tibiae and femora of female and male ostriches.

Sex	Live weight (g)	Bone	BMD (mm Al)	BR (kgf/cm²)	SI	DM (%)
Male	103300	Tibia	14.16	649.27	18,93	81,13
		Femur	6.98	298.67	16,20	76,79
Mean			10.57 ± 1.42	473.97 ± 25.02	17,56 ±1,24	78,96 ±3,82
Coefficient of variation			1,12	1,37	1.02	1.56
Female	88967	Tibia	13.49	462.53	17,99	77,45
		Femur	5.61	249.77	15,40	74,07
Mean			9.55 ± 1.28	356.15 ±21.05	16,69 ± 1,13	75,76 ± 3,89
Coefficient of variation			1,08	1,30	0.98	1.50

Table 4 - Correlations among weight gain, live weight, and bone quality in ostriches.

	WG	LW	BMDT	BMDF	BST	BSF	SIT	SIF	DMT	DMF
WG	1.00									
LV	0.61	1.00								
BMDT	-	-	1.00							
BMDF	-	-	0.54	1.00						
BST	-	0.73	0.68	-	1.00					
BSF	-	-	-	0.69	-	1.00				
SIT	-	0.53	0.57	0.54	0.49	-	1.00			
SIF	-	-	-	0.69	-	0.50	0.47	1.00		
DMT	-	0.62	0.42	0.22	0.33	-	0.69	-	1.00	
DMF	-	0.88	-	0.37	-	0.41	-	0.57	0.72	1.00

WG= weight gain; LW= live weight; BMDT = tibia bone mineral density; BMDF= femur bone mineral density BST = tibia bone strength; BSF= femur bone strength; SIT = tibia Seedor index; SIF= femur Seedor index; DMT = tibia dry matter percentage; DMF = femur dry matter percentage. Non-significant correlations are not presented, and are expressed as " –".

bones were correlated only to bone quality characteristics, and bone strength and dry matter presented correlation only within the same bone. Skeletal disorders may be triggered when the growth rate of other tissues increase, especially of muscle, without a corresponding increase in bone growth rate (Rennie *et al*., 1997; Kestin *et al*., 1999; Rath *et al*., 1999; Almeida Paz & Bruno, 2006).

CONCLUSION

It was concluded that male and female ostriches present similar performance and bone quality at slaughter age, suggesting that, independent of sex, the bones of these birds are able to support the fast weight gain rate that occurs during the finishing phase.

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