Gender effect on the metabolic profile of ostriches (*Struthio camelus domesticus*)

Giuseppe Moniello[1], Fulvia Bovera[2], Nicola De Riu[1], Giovanni Piccolo[2], Walter Pinna[1], Carmelo Di Meo[2]

[1]Dipartimento di Biologia Animale. Università di Sassari, Italy
[2]Dipartimento di Scienze Zootecniche e Ispezione degli Alimenti. Università di Napoli Federico II, Italy

Corresponding author: Prof. Giuseppe Moniello. Dipartimento di Biologia Animale. Facoltà di Medicina Veterinaria, Università di Sassari. Via Vienna 2, 07100 Sassari, Italy - Tel. +39 079 229443 - Fax: +39 079 229477 - Email: moniello@uniss.it

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ABSTRACT

In order to better define the effect of the sex on the metabolic profile of young ostriches (*Struthio camelus domesticus*), forty birds were divided into two groups by sex (20 males *vs* 20 females). The animals were fed *ad libitum* natural pasture and corn silage. The daily ration was completed by administering 1200 g/head of a commercial concentrate with the following chemical composition expressed as a percentage of dry matter: crude protein 18.8, crude fibre 8.4, ether extract 3.6, ash 7.5. After about 12 h of fasting, in the morning the blood was collected from the wing vein. The following biochemical parameters were determined: glucose, cholesterol, triglycerides, lactate (LAC), total protein (TP), uric acid, total bilirubin (Tbil), creatinine (CREA), calcium (Ca), magnesium (Mg), phosphorus (P), natrium (Na), potassium (K), chloride (Cl), iron (Fe), aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (AP), cholinesterase (ChE); α-amylase (Amyl), lipase (LIPA); γ-glutamyltransferase (GGT).
Sex significantly affected only some haematic parameters: in the females total protein and calcium were higher than in the males (TP, 43.3 *vs* 38.9 g/l, respectively for females and males, $P< 0.05$; Ca, 2.99 *vs* 2.59 mmol/l, respectively for females and males, $P< 0.01$). The other haematic parameters did not show significant differences by sex, and the average values were: glucose (9.87 mmol/l), cholesterol (1.96 mmol/l), triglycerides (1.56 mmol/l), LAC (6.60 mmol/l), uric acid (361 mmol/l), CREA (31.95 μmol/l), Na (144.8 mmol/l), K (3.27 mmol/l), Cl (109.7 mmol/l), P (1.47 mmol/l), Mg (1.10 mmol/l), Fe (9.22 μmol/l), Tbil (9.28 μmol/l), AST (341.3 U/l), ALT (11.42 U/l), AP (75.8 U/l), GGT (10.07 U/l), Amyl (6.97 U/l), LIPA (241.2 U/l), ChE (385.1 U/l).
The results of our study, in agreement with previous findings, contribute to enhance the knowledge on the metabolic profile of ostriches in function of the sex.

Key words: Ostrich, Metabolic profile, Sex.

RIASSUNTO

EFFETTO DEL SESSO SUL PROFILO METABOLICO DEGLI STRUZZI (*STRUTHIO CAMELUS DOMESTICUS*)

Allo scopo di studiare l'effetto del sesso sul profilo metabolico di giovani struzzi (Struthio camelus domesticus) *quaranta animali sono stati divisi in due gruppi in funzione del sesso (20 maschi vs 20 femmine). Gli animali disponevano di pascolo naturale e di silomais a volontà. La razione giornaliera*

veniva completata con la somministrazione pro-capite di 1200 grammi di un mangime commerciale avente la seguente composizione chimica (%SS): protidi grezzi 18,8, fibra grezza 8,4, lipidi grezzi 3,6, ceneri 7,5. Campioni di sangue furono prelevati a tutti gli animali in prova al mattino, dopo circa 12 ore di digiuno, dalla vena alare per determinare i seguenti parametri: glucosio, colesterolo, trigliceridi, lattato (LAC), proteine totali (TP), acido urico, bilirubina totale (Tbil), creatinina (CREA), calcio (Ca), magnesio (Mg), fosforo (P), sodio (Na), potassio (K), cloro (Cl), ferro (Fe), aspartato aminotransferasi (AST), alanina aminotransferasi (ALT), fosfatasi alcalina (AP), colinesterasi (ChE), α-amilasi (Amyl), lipasi (LIPA), γ-glutamiltransferasi (GGT).

Il sesso ha influenzato significativamente solo alcuni parametri ematici: nelle femmine sono risultati più alti i valori delle proteine totali (43,3 vs 38,9 g/l, rispettivamente per femmine e maschi, P< 0,05) e del calcio (2,99 vs 2,59 mmol/l, rispettivamente per femmine e maschi, P< 0,01). Gli altri parametri ematici esaminati non hanno presentato differenze significative tra i due sessi e i valori medi sono risultati: glucosio (9,87 mmol/l), colesterolo (1,96 mmol/l), trigliceridi (1,56 mmol/l), LAC (6,60 mmol/l), acido urico (361 mmol/l), CREA (31,95 μmol/l), Na (144,8 mmol/l), K (3,27 mmol/l), Cl (109,7 mmol/l), P (1,47 mmol/l), Mg (1,10 mmol/l), Fe (9,22 μmol/l), Tbil (9,28 μmol/l), AST (341,3 U/l), ALT (11,42 U/l), AP (75,8 U/l), GGT (10,07 U/l), Amyl (6,97 U/l), LIPA (241,2 U/l), ChE (385,1 U/l).

I risultati della nostra ricerca, peraltro in accordo con quanto riscontrato da altri autori, contribuiscono a migliorare le conoscenze sul profilo metabolico degli struzzi in funzione del sesso.

Parole chiave: *Struzzo, Profilo metabolico, Sesso.*

Introduction

Blood profiling, initially used to detect subclinical metabolic disorders due to incorrect feeding, has recently been applied more widely to evaluate the effects of different treatments on metabolic, nutritional and animal welfare conditions (Bertoni *et al.*, 2000). On medium–large farms, metabolic profile determination can be very useful when a decrease in production and/or reproduction is not associated to clinical signs. Though initially the most extensively studied livestock species was the dairy cow, due to interest on the part of the scientific community, the study of metabolic profiles was later extended to all other major livestock species. Hence, it seemed worth studying the metabolic profiles of ostriches (*Struthio camelus domesticus*): although the species has been widely adopted in Europe, with numbers in Italy alone amounting to more than 40,000 head (ISTAT, 2000), relatively little is known on its metabolic profile (Van Heerden *et al.*, 1985; Levy *et al.*, 1989; Angel, 1996; Brown and Jones, 1996).

Nevertheless, in order to correct interpretation of metabolic profiles, it is necessary to have normal values as standard. Such values can change according to many factors such as age, season, physiological status, sex, blood collection method and stress. A previous study (Moniello *et al.*, 2005) reported the results of the metabolic profile obtained as a function of collection site and ostrich age. The present paper aims to evaluate the effect of sex on the metabolic profile of ostriches.

Material and methods

The study was carried out on 40 two-year-old ostriches (20 males and 20 females) born and raised on the island of Sardinia. The animals, raised in collective boxes (20 birds/box, about 25 m^2/bird), were fed *ad libitum* natural pasture and corn silage. The daily ration was completed by administering 1200 g/head of a commercial concentrate with the following chemical composition expressed as percentage of dry matter: crude protein 18.8, crude fibre 8.4, ether extract 3.6, ash 7.5 (AOAC, 1984).

To blood collection, animals were captured by a neck-baton and their heads covered in a woollen sock during sampling for ease of containment. The ostriches were healthfully when the blood was collected and did not

manifest disease signs before and after collecting. From each animal, in the morning (from 8.00 to 10.00 h), after about 12 hours' fasting, blood collection by vacutainer was made from the wing vein (*v. ulnaris subcutanea*). This collection site was chosen because the vein is large and easily located. Moreover, in comparison to the common collection, made on the jugular vein, it appears safer for the collector, who can avoid possible front-kicks from the animal by taking the sample at the animal's side. On the other hand, in a previous study (Moniello *et al.*, 2005) the two collection sites (jugular vs. wing vein) supplied similar blood parameter values.

Within one hour, the blood samples were centrifuged in order to obtain the serum, immediately frozen at - 21 °C, before the analytical determinations. The analyses were carried out in the Department of Animal Biology at the University of Sassari (Italy) using an automated system (Ektachem 250 analyzer, KODAK) based on dry chemistry: serum samples are dispensed on a small plate constituted by a support with several coats, the intermediate containing the reagents for the colorimetric reaction, quantified by UV Spectrometer. The analyses were made using the following methods (specific kits Ektachem - Clinical Chemistry Slides by Johnson & Johnson Clinical Diagnostic, Milan, Italy):

- colorimetric for calcium (Ca), magnesium (Mg), phosphorus (P), glucose, total protein (TP), cholesterol, triglycerides, lactate (LAC), uric acid, total bilirubin (Tbil), γ-glutamyltransferase (GGT);
- enzymatic-colorimetric for creatinine (CREA), α-Amylase (Amyl), lipase (LIPA);
- spectrophotometric for aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (AP), cholinesterase (ChE);
- potentiometer for sodium (Na), potassium (K), chloride (Cl), iron (Fe), by specific electrodes.

Amylase values were converted to natural logarithms in order to normalize the distribution.

Statistical analysis was carried out by ANOVA (SAS, 2000), using the model:

$$Y_{ik} = \mu + A_i + \varepsilon_{ik}$$

where:
Y is the single observation;
μ is the general mean;
A is the effect of sex (i = male or female);
ε is the error.

Results and discussion

The results about the effect of sex on the metabolic profile of ostrich are reported in Table 1.

Energetic metabolism

The main parameters of energy metabolism (glucose, cholesterol and triglycerides) were no significative different (average 9.9, 1.9 and 1.6 mmol/l, respectively for glucose, cholesterol and triglycerides) between males and females (Table 1) and in agreement with those reported in the literature (Van Heerden *et al.*, 1985; Levy *et al.*, 1989). Also in a previous study similar values for glucose and cholesterol in 12- and 24-month-old animals were found (Moniello *et al.*, 2005), but not for triglycerides, whose values were about 1 mmol/l. The lack of gender differences for these parameters could be due to the age of the animals that although had reached body maturity, had not yet started reproductive activity.

In comparison to the correspondent values reported for more commonly raised birds (chicken, turkey) by other authors (Franchini *et al.*, 1990; Chiericato and Rizzi, 1999a, 1999b), our ostriches showed lower glucose and cholesterol contents and higher levels of triglycerides.

Protein metabolism

Different values of total serum protein were observed between ostriches of different sex (Table 1). The higher protein concentra-

tion in females (43.3 *vs* 38.9 g/l) could be explained by the high level of oestrogen hormones in females responsible of the high content of serum globulins (Sturkie and Newman, 1951). Our results are in agreement with those (g/l 37-43) reported in the literature (Van Heerden *et al.*, 1985; Levy *et al.*, 1989; Palomeque *et al.*, 1991; Okotie-Eboh *et al.*, 1992; Angel, 1996; Moniello *et al.*, 2005). Furthermore, the blood protein content in ostriches was also in agreement with average values (g/l 40) reported for the birds (Bell and Freeman, 1971).

As regard to the other parameters no significant differences between sex were found. The average values for uric acid (average 361 mmol/l) and creatinine (average 32.0 μmol/l) were similar with other findings (Levy *et al.*, 1989; Moniello *et al.*, 2005). In ostrich with normal renal function a direct relationship seems to exist between muscle mass and serum creatinine. A creatinine increase normally occurs when the muscular tissue turnover accelerates (Finco, 1989). Higher blood creatinine values were observed by Campanile *et al.* (1990) also in lambs treated with clenbuterol in order to increase muscular tissues. In this regard, Fekry *et al.* (1989) assert that the modifications in haematic creatinine content could be useful to estimate the changes in muscle protein. At the light of these observations, we may assume that we did not find differences between sexes because the muscular mass and the turnover of muscular tissues was almost similar between males and females.

Serum enzymes and bilirubin

Serum enzymes (GGT, AST, ALT, AP, LAC, Amyl, LIPA, ChE) showed no significant gender differences. Irrespective of species and in the presence of healthy animals, variation in serum enzymes is to be attributed to the evolving of physiological conditions that change the activity of the different systems. Very often, higher values of serum enzymes are found in young ostriches where tissue growth and change are higher. In our case, similar serum enzyme values between sexes could indicate that changes due to the reproductive activity of the animals examined had not started.

GGT showed higher contents (average 10.1 U/l) in comparison to those reported in the literature (Van Heerden *et al.*, 1985; Levy *et al.*, 1989; Okotie-Eboh *et al.*, 1992). Moreover, regarding GGT, standard values for ostriches have not yet been defined and those recorded in the chicken by Franchini *et al.* (1990) are higher (U/l 3-9).

The alkaline phosphatase showed lower levels (average 75.8 U/l) in comparison to those (U/l 150-575) previously reported (Levy *et al.*, 1989; Okotie-Eboh *et al.*, 1992). Higher levels are also recorded (U/l 279-666) in the emu. This enzyme is normally higher in young animals when bone metabolism is more intense. Accordingly, Costa *et al.* (1993) report in emus lower AP values in adult than in two-month-old animals. In our case, the low levels recorded in both sexes could be explained by the fact that the animals finished the body growth, but the metabolic changes of the reproductive activity are not yet evident.

AST and ALT showed high variability in individual values (an average 341.3 and 11.4 U/l, respectively, for AST and ALT). Very high variability is also found in the literature: AST ranged from 131 U/l (Levy *et al.*, 1989) to 372.2 U/l (Angel, 1996), ALT from 2.0 U/l (Levy *et al.*, 1989) to 20.62 U/l (Palomeque *et al.*, 1991). On the other hand, also in other species (Bertoni *et al.*, 2000) these enzymes showed high variability and normally higher values during growth due to changes in the tissues and intense synthesis occurring at this stage of life.

The values of amylase (average 6.97 U/l) and lipase (average 241.2 U/l) are difficult to comment upon since there are scant data on this topic in the literature. In previous research Moniello *et al.* (2005) found that lipase ranged from 238 to 322 U/l and amylase from 6.85 to 7.07. As these enzymes are linked to pancreatic activity and their high values indicate the

Table 1. Metabolic profile.

Parameters		General mean	Sex of ostriches		MSE	P
			Male	Female		
Glucose	mmol/l	9.88	10.06	9.69	1.80	0.40
Cholesterol	"	1.96	1.85	2.07	0.20	0.18
Triglycerides	"	1.56	1.56	1.56	0.17	0.99
LAC	"	6.60	6.51	6.68	4.06	0.79
TP	g/l	41.13	38.90	43.35	39.27	0.03
Uric acid	mmol/l	361.6	364.4	358.7	7037.5	0.83
Crea	μmol/l	31.95	32.75	31.15	54.85	0.50
Na	mmol/l	144.9	143.9	145.8	82.99	0.51
K	"	3.27	3.44	3.10	0.29	0.15
Cl	"	109.8	108.1	111.4	42.82	0.11
Ca	"	2.79	2.59	2.99	0.09	0.01
P	"	1.47	1.41	1.52	0.04	0.10
Mg	"	1.10	1.12	1.07	0.02	0.33
Fe	μmol/l	9.22	9.14	9.30	6.41	0.85
Tbil	"	9.28	9.30	9.25	10.84	0.96
AST	U/l	341.3	326.5	356.1	2871.8	0.09
ALT	"	11.43	11.65	11.20	5.15	0.53
AP	"	75.8	71.4	80.2	296.9	0.11
GGT	"	10.08	10.10	10.05	12.91	0.97
Amyl	"	6.97	7.01	6.93	3.54	0.39
LIPA	"	241.3	242.1	240.4	4736.8	0.94
ChE	"	385.2	391.5	378.8	9022.8	0.68

LAC – lactate; TP - total protein; Tbil - total bilirubin; Crea - creatinine; AST – aspartate aminotranferase; ALT – alanine aminotranferase; AP - alkaline phosphatase; GGT – γ-g1utamy1transferase; Amyl - amylase; LIPA - lipase; ChE – cholinesterase

animal's poor state of health, the recorded values have to be considered physiological.

The levels of lactate (average 6.6 mmol/l) confirmed those recorded in the previous trial (Moniello *et al.*, 2005) with animals of the same age. Regarding cholinesterase, the observed values (average 385.1 U/l) are slightly lower than those (654 - 496 U/l) found in the literature (Okotie-Eboh *et al.*, 1992; Moniello *et al.*, 2005). Serum bilirubin levels (average 9.28 μmol/l) fall in the physiological range of the species (Levy *et al.*, 1989; Palomeque *et al.*, 1991) excluding hepatic or muscular pathologies.

Mineral metabolism

Blood mineral contents and their ratios evidenced, beyond sub-clinical pathologies, above all mineral deficiencies. This is a useful parameter in ostriches as their nutrition is very often determined by breeders, irrespective of animal nutritive requirement.

Levels of calcium (average 2.6 mmol/l), phosphorus (average 1.82 mmol/l) and magnesium (average 0.85 mmol/l) were in agreement with the literature (Van Heerden *et al.*, 1985; Levy *et al.*, 1989; Bezuidenhout *et al.*, 1994). Higher calcium in females (2.99 vs 2.59 mmol/l) seems to indicate that in this

one the parameter could have higher values also in non–reproductive age. Also in growing turkeys (Franchini *et al.*, 1990) higher values were observed in females. The lack of variability in magnesium, given that the blood level of this mineral depends especially on feed availability and intestinal absorption, assumes great importance such that blood Mg content is normally considered a useful index of nutritional status, at least in the short term.

Na (144.9 mmol/l), Cl (109.8 mmol/l) and K (3.3 mmol/l) showed values within the physiological range of the species (Van Heerden *et al.*, 1985; Levy *et al.*, 1989; Brown and Jones, 1996). Moreover, these minerals normally show little variability in ostriches even in different physiological conditions.

Iron showed average levels of 9.2 μmol/l, slightly higher than those (average 7.0 μmol/l) found in previous research (Moniello *et al.*, 2005), but lower than those (16.2 μmol/l) reported by Van Heerden *et al.* (1985).

Conclusions

Our results indicate that sex has a limited effect on the metabolic profile in two-year-old ostriches, probably because the animals are not yet in their reproductive phase. In general, the average values of haematic parameters between sexes found in our study were in agreement with those reported in the literature. The differences between our results and those of other authors for some parameter have to be linked to different research plans, to the use of animals and diets with different characteristics and to the different climatic conditions in which the trials were conducted. Nevertheless, it is evident that the paucity of studies on the metabolic profile of ostriches needs to be rectified in order to provide standard values of reference.

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