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

Giuseppe Moniello¹, Fulvia Bovera², Nicola De Riu¹, Giovanni Piccolo², Walter Pinna¹, Carmelo Di Meo²

¹Dipartimento di Biologia Animale. Università di Sassari, Italy
²Dipartimento 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 (389.1 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
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 m²/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 wooden 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:

\[ Y_{ijk} = \mu + A_i + \epsilon_{ijk} \]

where:
- \( Y \) is the single observation;
- \( \mu \) is the general mean;
- \( A \) is the effect of sex (\( i = \) male or female);
- \( \epsilon \) 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 significant 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 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
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 (Okorie-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

| Parameters  | General mean | Sex of ostriches | MSE | P |
|-------------|--------------|-----------------|-----|---|
| 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 aminotransferase; ALT – alanine aminotransferase; AP - alkaline phosphatase; GGT – γ-glutamyltransferase; Amyl - amylase; LIPA - lipase; ChE – cholinesterase

Table 1. Metabolic profile.
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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