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ORIGINAL ARTICLE

Selected biochemical values of yearling African blue neck ostriches (*Struthio camelus*) in Iran

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Abstract Ten 12-month-old male clinically healthy young blue neck breed ostriches (*Struthio camelus*) from Zabol district of Sistan, Baluchestan province, Iran were blood sampled in plain tubes for harvesting serum. The concentrations of total protein, albumin, cholesterol, HDL cholesterol, LDL cholesterol, triglyceride, uric acid, calcium, inorganic phosphorus, and the activity of aspartate aminotransferase (AST), alanine aminotransferase (ALT), and gamma glutamyl transferase (GGT) were measured. The following results were obtained: total protein, 35.3±2 g/l; albumin, 16.4±1.53 g/l; globulin, 18.9±0.8 g/l; total cholesterol, 1.67±0.11 mmol/l; LDL cholesterol, 0.68±0.07 mmol/l; HDL cholesterol, 0.67±0.02 mmol/l; triglyceride, 0.70±0.1 mmol/l; uric acid, 302.15±20.81 μmol/l; calcium, 2.27±0.15 mmol/l; inorganic phosphorus, 1.81±0.13 mmol/l; AST, 246.3±22.4 IU/l; ALT, 8.4±0.52 IU/l; and GGT activity, 26.9±2.97 IU/l. Correlations between measured parameters were also determined. Blood biochemical values determined in this study can be considered as reference data for disease diagnosis in yearling African blue neck ostriches (*S. camelus*) in Iran.

Keywords Ostrich (*Struthio camelus*) · Biochemical parameters · Yearling

Introduction

Ostriches (*Struthio camelus*) are a relic of the dinosaur age. The ostrich, (order Struthioniformes, family Struthionidae), a fast-running flightless ratite, is the largest living bird that lays the largest eggs. The ostrich has no crop and lacks a gallbladder. Wild ostriches are found exclusively in Africa. Over the past two decades, their industry has expanded throughout the world. The ostrich is farmed around the world. Ostriches have high potential to produce healthy red meat with low fat content. Feather dusters and leather are important products of ostriches. Anti-inflammatory effects of ostrich extract are also considered. Ostrich eggshell is used as a bone substitute (Dupoirieux 1999). Ostriches can now be found in many countries of the world such as Iran. The knowledge of ostrich adaptation (represented in blood biochemistry) to its new environment could suggest some information for ostrich veterinary care and production. Blood biochemistry is the only means by which metabolic and nutritional problems can be diagnosed with certainty. These data, especially in distinctive age, should be strictly interpreted because they are necessary together with good anamnesis and physical examination for reaching a proper diagnosis (Perelman 1999). All ostriches in the present study hatched out of eggs at exactly the time, so they have the same age, which leads to exact results. This study describes some serum biochemistry values of young African blue neck ostriches in Iran.

Materials and methods

The study was performed on ten 12-month-old male clinically healthy blue neck breed ostriches, (body weight range, 70–100 kg), hatched and reared in a single herd located in specific animal research center of Zabol district in Sistan, Baluchestan province, Iran. Zabol's location is 31° 1′ 47″ north latitude, 61° 29′ 52″ east longitude, and Zabol has an average elevation of about 478 m above sea level. The diet

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Table 1 Some biochemical parameters in serum of young ostriches (*S. camelus*)

	Unit	$P_{2.5–97.5}$[a]	Mean	SEM	SD	Median	Range
Total protein	g/l	22–40	35.3	2	6.32	39	18
Albumin	g/l	9–22	16.4	1.53	4.85	18	13
Globulin	g/l	13–22	18.9	0.8	2.55	19	9
Total cholesterol	mmol/l	1.15–2.15	1.67	0.11	0.36	1.65	1
LDL cholesterol	mmol/l	0.3–1	0.68	0.07	0.24	0.73	0.69
HDL cholesterol	mmol/l	0.56–0.82	0.67	0.02	0.08	0.67	0.25
Triglyceride	mmol/l	0.31–1.22	0.70	0.1	0.32	1.65	0.91
Uric acid	μmol/l	196.28–434.2	302.15	20.81	67.21	300.37	237.92
Calcium	mmol/l	1.52–2.75	2.27	0.15	0.48	2.45	1.25
Inorganic phosphorus	mmol/l	1.22–2.42	1.81	0.13	0.43	1.98	1.19
AST	IU/l	122–311	246.3	22.4	70.9	282	189
ALT	IU/l	6–11	8.4	0.52	1.64	8.5	5
GGT	IU/l	2.20–15	7.01	1.44	4.58	5.25	12.80

SD standard deviation

[a]Recommended reference values

was a mixture of a commercial ostrich pellet, 2 kg/bird/day, and alfalfa hay ad libitum. The diet was supplemented with multivitamins and electrolytes (Erfan Darou, Iran). Water was provided ad libitum also. They were kept in an enclosure with 1,200 m^2 of open space and 90 m^2 of covered space. Blood samples for the determination of some parameters were obtained between 8 and 9 am, to avoid diurnal influences, following about a 12-h fasting by wing vein (*vena cutanea ulnaris*) into vacutainers. The serum was prepared by removing the clot from the whole blood sample and subsequent centrifugation at 2,500×*g* for 15 min. Sera were stored at −21°C until analysis. The biochemical parameters were measured using a standard autoanalyser (Hitachi 717, Boehringer. Mannheim, Germany). The level of total serum protein by Biuret reaction (Gornall et al. 1949), albumin by Bromocresol green dye binding method (McGinlay and Payne 1988), and serum globulin was estimated by subtracting albumin from the total protein. Cholesterol, HDL cholesterol, LDL cholesterol, (by modified Abell–Kendall/Levey–Brodie method), (Edwards et al. 2011), triglyceride by enzymatic method (Hinscha et al. 1980), uric acid by phosphotungstic acid method, calcium by orthocresolphthalein method, inorganic phosphorus by ammonium molybdate method, and the activity of aspartate aminotransferase (AST), alanine aminotransferase (ALT), and gamma glutamyl transferase (GGT) was measured by the colorimetric method of Reitman and Frankel(Mansour et al. 1982). Serum enzyme activities were measured according to the specific reaction of each enzyme by using basic standard techniques. All results of enzyme activities were expressed in international units per liter written as IU/l (Burtis and Ashwood 1994). Descriptive statistics are expressed as means and standard error of mean (SEM), $P_{2.5–97.5}$ as reference values, standard deviation (SD), median, and range using SPSS 16/PC software (Norusis 1993). The experiment was approved by the animal welfare committee of the Agriculture Faculty of Birjand University.

Results and discussion

We present the serum chemistry descriptive statistics and reference values for young ostriches in Table 1. The inner limits of the percentiles $P_{2.5–97.5}$ with a probability of 90% are reported. Various factors such as age, sex, season, and nutritional and physiological status can affect the blood parameters. Because of the strong influence of age on some values (Levy et al. 1989), we selected all ostriches at exactly the same age. The current study found that the mean ± SEM of total protein, albumin, and globulin was 35.3±2, 16.4± 1.53, and 18.9±0.8 g/l, respectively. In the ostrich, serum

Table 2 Spearman rank correlation values between ostrich serum biochemical parameters

Parameter A	Parameter B	Correlation coefficient
Total protein	Albumin	0.912[a]
Total protein	Cholesterol	0.765[a]
Total protein	Triglyceride	0.772[a]
Total protein	Calcium	0.849[a]
Albumins	Cholesterol	0.815[a]
Albumins	Calcium	0.970[a]
Cholesterol	Calcium	0.827[a]
Cholesterol	Inorganic phosphorus	0.770[a]
Cholesterol	LDL cholestrol	0.848[a]
Triglyceride	Inorganic phosphorus	0.903[a]
ALT	GGT	0.766[a]

[a] Correlation is significant at the 0.01 level (two-tailed)

total protein is 20–50 g/l (Cooper et al. 2010). These findings of the current study are consistent with those of Perelman (1999) who found that the total serum protein concentration in young ostriches was lower (36 g/l) than in adults (45 g/dl). The results of the current study are consistent with those previously reported in young ostriches (Perelman 1999; Levy et al. 1989; Khaki et al. 2010). Avian total proteins consist of albumins, globulins, and transferrin. All plasma proteins, except immunoglobulins, are manufactured in the liver (Lehninger 1978). There was a strong relationship between total protein and albumin (Table 2, r=0.912 and $p \leq 0.01$). Albumin represents a large part of total proteins. When the protein content in feed exceeds the animals' requirements, its levels will rise (Costa et al. 1993). The results of this study indicate that the mean ± SEM of total cholesterol, LDL cholesterol, HDL cholesterol, and triglyceride was 1.67±0.11, 0.68±0.07, 0.67±0.02, and 0.70± 0.1 mmol/l, respectively. Variations of energy-related biochemical metabolites (cholesterol and triglycerides) in young ostriches were lower and in a narrower range than cholesterol concentrations and similar triglyceride values in other birds such as young white storks (Montesinos et al. 1997), Golden eagle, Egyptian vulture, Griffon vulture, and Spanish imperial eagle (Polo et al. 1992). Cholesterol concentrations were similar to the average values of several previous studies on ostriches (Levy et al. 1989). The ostriches were fed the same diet in this study, and so the diet has no influence on all these variables (Thrall et al. 2004). Uric acid is the major nitrogenous waste product of birds and is useful in the determination of kidney failures. Mean ± SEM of uric acid was 302.15±20.81 μmol/l. This finding is in agreement with other findings but in narrower range (Levy et al. 1989). Some studies showed higher average level of uric acid, 484 and 590 μmol/l (Verstappen et al. 2002). It seems possible that these results are due to the exact same age of ostriches in this study; hence, levels of uric acid in birds increased with rich protein diets (Bell and Sturkie 1965). Both calcium and inorganic phosphorus levels may be indicators of renal function and may help to evaluate nutritional deficiencies in ostriches. Calcium and inorganic phosphorus concentrations were 2.27±0.15 and 1.81±0.13 mmol/l, respectively. Levels of calcium and inorganic phosphorus concentration are consistent with those of other studies in ostriches (Levy et al. 1989). Serum AST and ALT activity were 246.3±22.4 and 8.4±0.52 IU/l, respectively. AST values ranged from 131 to 372.2 IU/l in other studies (Levy et al. 1989; Angel 1996), and ALT values ranged from 2 to 26.62 IU/l in other studies (Levy et al. 1989; Palomeque et al. 1991). Because of variations in the activity values of these enzymes, and their distribution in other tissues, their interpretation is difficult (Thrall et al. 2004). Serum GGT activity was 7.01±1.44 IU/l. Reference values of 0–10 IU/l are normal in birds. GGT is an indicator of biliary and renal epithelium disorders. Marked increases in GGT activity in birds with bile duct carcinoma have been reported (Phalen et al. 1997). The level of GGT activity is consistent with some of other studies in ostriches (Levy et al. 1989). Our results are higher than some previous works in this field, 0–1 IU/l (Verstappen et al. 2002). There are several possible explanations for this result, such as variable sensitivity of laboratory instruments and age of ostriches. AST, ALT, and GGT enzyme activities in birds are variable and originate from muscle, skeletal, and cardiac, liver, and some other tissues. Reference intervals of these have not been established for all bird species (Fernandez et al. 1994). Significant correlations were found between some parameters which were reported in Table 2. The relationship between total protein and albumin concentrations with serum calcium concentration was seen, (r=0.849 and $p \leq 0.01$) and (r=0.970 and $p \leq 0.01$), respectively. These results are consistent with those of other studies in ostriches (Verstappen et al. 2002), African gray and Amazon parrots (Lumeij 1990), and peregrine falcons (Lumeij et al. 1993). There was a relationship between cholesterol concentrations with serum calcium concentration (r=0.827 and $p \leq 0.01$). Also, the relationship between albumin concentrations with serum calcium concentration was very high (r=0.970 and $p \leq$ 0.01) because calcium is bound mainly to albumin, and this part of total calcium is biologically inactive. In conclusion, further study is needed to characterize blood biochemistry values appropriate to be used as reference values in all ages of ostriches in Iran. It should be noted that the use of anesthetic drugs such as xylazine, ketamine, and isoflurane can alter some blood parameters (Al-Sobayil and Omer 2011).This knowledge of ostrich adaptation to Iran environment could help veterinary care and production.

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