



## Serum biochemical values of farmed ostrich (*Struthio camelus*) in Botswana

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### ABSTRACT

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Reference biochemical values for serum analytes of 126 clinically normal farmed ostriches on one farm in Botswana were established. These included sodium, potassium, chloride, total protein, albumin, urea, creatinine, uric acid, cholesterol, total bilirubin, conjugated bilirubin, glucose, triglyceride, calcium, phosphorus, manganese, copper, zinc, alkaline phosphatase, gamma glutamyl transferase and creatinine kinase. The values obtained in this study can be used as reference values.

**Keywords:** Biochemical values, Botswana, ostrich, serum, *Struthio camelus*

### INTRODUCTION

Establishment of baseline concentration levels for blood constituents is a prerequisite for accurate interpretation of clinical pathological data. These are however often subject to variation due to factors such as age, sex, physiological status and animal husbandry practices, and ecological factors such as geographical location. Paucity of information on the ostrich (*Struthio camelus*) makes the need for this knowledge even more urgent in countries where ostrich farming is in its infancy.

Concentrations of biochemical variables are used to diagnose illness not only in domestic animals (Bruguere-Picoux, Bruguere, Basset, Sayad, Vaast & Michaux 1987; Kaneko 1989), but also birds (Woerpel & Roskopf 1984). Comparative values of ostrich blood chemistry have been presented by various

authors (Stoskopf, Beall, Ensley & Neely 1982; Van Heerden, Dauth, Jarvis, Keffen, Denny, Dreyer & Kriek 1985; Levy, Perelman, Waner, Grevenbroek, Van Creveld & Yagil 1989; Palomeque, Pinto & Viscor 1991; Okotie-Eboh, Bailey, Hicks & Kubena 1992).

The main objective of this paper was to present baseline levels of some blood constituents of clinically normal adult ostriches aged about 2 years.

### MATERIALS AND METHODS

Blood samples were obtained from 126 clinically normal, farmed adult ostriches of either sex, aged about 2 years, just before the breeding seasons of the hens started. The birds were kept in fenced pens and were fed *ad libitum* on a commercial ostrich feed ration. The feed contained:

plant protein (cotton seed cake)	15,40 %
crude fibre	12,00 %
calcium	1,70 %
phosphorus	1,00 %
magnesium	0,48 %
manganese	360 mg/kg
zinc	175 mg/kg
selenium	0,42 %
Vitamin E	49 mg/kg

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These ostriches were hatched from eggs laid on an ostrich farm in Lobatse District, Botswana. They were placed in a crush in order to restrain them for the bleeding operation. Prior to bleeding, the birds were blindfolded with a sock made out of semi-transparent material to minimize the stress of handling. The brachial vein—the preferred site for venipuncture in ostriches—was exposed, cleansed with a cotton swab, moistened with an aqueous solution of Savlon (a disinfectant containing chlorhexidine gluconate (Johnson & Johnson, East London, South Africa), followed by another swab moistened with 70% alcohol. Blood was collected into vacutainer tubes without anticoagulant at the same hour (10:00–11:00) in order to reduce possible variations associated with diurnal changes. It was allowed to clot for 1 h at room temperature and the serum was immediately harvested to prevent the diffusion of potassium from the clot into the serum. Serum samples from each bird were kept in 1 ml aliquots at 4°C for a maximum of 4 h being analyzed. The sampling exercise was done during the course of 1 month in order to avoid introducing seasonal effects which usually influence the diet and the physiology of the birds.

Serum samples were analyzed for copper and zinc colorimetrically on a UV spectrophotometer (Shimadzu 1601) using commercial kits (Boehringer Mannheim Diagnostics, Germany) for copper and (Wako Chemicals GmbH, Germany) for zinc, respectively. Serum zinc levels were quantitated using an *in vitro* colorimetric method involving deproteinization with trichloroacetic acid. Thereafter, the zinc that is released binds to a chromogenic component forming a reddish violet chelate whose absorbance, when measured at a wavelength of 560 nm, is directly proportional to the amount of zinc in the serum. Serum copper was determined using diethyldithiocarbamate as the chromogen with the resulting golden yellow complex which is read at a transmission wavelength of 440 nm. The detailed protocols for the methodologies for both copper and zinc were as stipulated by the manufacturers of the kits who also provided the control serum samples for the tests.

The manganese (Mn) content of the serum samples was determined using Atomic absorption spectro-

metry (Model-Varian Techtron). Samples were read using a hollow cathode lamp current of 4 mA, the slit width was 0,5 nm and the wavelength optimized at about 279,5 nm. Average absorption was determined over a period of 5 s. The concentration of Mn in the sample was determined using a linear calibration curve of three prepared standards (Clinical Science Diagnostics, South Africa).

The analytes shown in Table 4: phosphorus, calcium and magnesium including enzyme activities, were determined from serum using a chemical analyzer (Vitalab Selectra, Merck Instruments) fitted with an isoselective electrode (ISE) for the determination of electrolytes—sodium, potassium and chloride. This chemical analyzer has a built-in automatic calibration system using commercial calibrators (SMT calibrator, Merck) supplied with the reagent with the kits.

Parametric means (means  $\pm$  s.d.) and reference ranges including outlying figures, were determined.

## RESULTS AND DISCUSSION

Mean values and reference ranges of some ostrich blood analytes are presented in Tables 1–4. The present study showed that the mean value of the serum electrolyte sodium was higher than that reported by other authors, Levy *et al.* (1989) and Van Heerden *et al.* (1985). While the chloride value was comparable to the values given by these authors, the potassium value was significantly higher than that given by Van Heerden *et al.* (1985) and almost twice that obtained by Levy *et al.* (1989). This may probably be attributed to fast diffusion of potassium from the erythrocytes during blood clotting at room temperature.

The serum mineral levels of calcium, phosphorus and magnesium were also elevated compared to the values obtained by the other authors. Calcium metabolism is important in laying birds and bone mineralization (Mori & George 1978; Kenny 1986). Furthermore, Gandini, Burroughs & Ebedes (1986) demonstrated dietary calcium-responsive tarsometatarsal bone deviations. Deficient formation or poor mineralization of the osteoid matrix has also been associated with deficiencies in the micromine-

TABLE 1 Serum electrolyte concentrations in adult ostriches

Analyte	Mean $\pm$ s.d.	Range	References	
			A	B
Sodium (mmol/l)	152,00 $\pm$ 0,51	140,00–155,0	151,0	150,60
Potassium (mmol/l)	5,10 $\pm$ 0,18	2,20–7,00	2,8	3,45
Chloride (mmol/l)	104,00 $\pm$ 0,60	8,50–115,0	106,0	103,90

A: Levy *et al.* 1989

B: Van Heerden *et al.* 1985

TABLE 2 Serum mineral levels of adult ostriches

Analyte	Mean $\pm$ s.d.	Range	References			
			A	B	C	D
Calcium (mmol/l)	2,910 $\pm$ 0,79	1,22–5,72	2,5	2,51	2,38	4,51
Phosphorus (mmol/l)	2,971 $\pm$ 0,86	1,00–5,93	1,4	1,73	1,60	4,43
Magnesium (mmol/l)	1,530 $\pm$ 0,47	0,58–2,75	1,4	0,81	–	0,92
Copper ( $\mu$ mol/l)	10,821 $\pm$ 1,69	7,65–20,66	–	–	–	–
Zinc ( $\mu$ mol/l)	7,630 $\pm$ 0,96	6,26–8,41	–	–	–	–
Manganese (ppb) <sup>a</sup>	34,000 $\pm$ 0,10	33,00–43,00	–	–	–	–

A: Levy *et al.* 1989B: Van Heerden *et al.* 1985C: Okotie-Eboh *et al.* 1992D: Palomeque *et al.* 1991<sup>a</sup> ppb = Parts per billion

TABLE 3 Serum enzyme levels in adult ostriches

Enzyme	Mean $\pm$ s.d.	Range	References			
			A	B	C	D
AP (I.U./l)	209,000 $\pm$ 50	153,00–820,00	575,00	479,00	150,00	171,5
Gamma GT (I.U./l)	19,000 $\pm$ 10	0,00–29,00	1,51	0,48	2,1	–
CK (I.U./l)	1,500 $\pm$ 200	400,00–2,140	688,00	1 529,00	2 470,00	933,0

A: Levy *et al.* 1989B: Van Heerden *et al.* 1985C: Okotie-Eboh *et al.* 1992D: Palomeque *et al.* 1991

TABLE 4 Other analyte levels in the serum of adult ostrich

Analyte	Mean $\pm$ s.d.	Range	References			
			A	B	C	D
Total protein (g/l)	45,25 $\pm$ 9,60	24,00–76,00	34,0	40,6	38,00	38,7
Albumin (g/l)	22,14 $\pm$ 4,50	10,00–33,00	–	20,4	18,00	–
Urea (mmol/l)	0,90 $\pm$ 0,01	0,40–10,00	0,4	0,49	0,39	1,67
Creatinine ( $\mu$ mol/l)	27,00 $\pm$ 5,00	17,00–33,00	28,0	36,6	35,36	56,6
Uric acid ( $\mu$ mol/l)	270,00 $\pm$ 15,00	200,00–500,00	487,0	–	536,00	664,4
Cholesterol (mmol/l)	1,58 $\pm$ 0,01	1,30–4,20	2,8	–	2,60	3,00
Total Bilirubin ( $\mu$ mol/l)	4,00 $\pm$ 0,01	0,00–8,00	5,9	–	–	2,24
Conjugated Bilirubin ( $\mu$ mol/l)	2,00 $\pm$ 0,01	1,80–3,00	–	–	–	–
Glucose (mmol/l)	7,60 $\pm$ 0,20	5,00–14,00	13,9	–	13,6	11,5
Triglyceride (mmol/l)	1,32 $\pm$ 0,06	1,00–1,80	1,2	–	–	–

A: Levy *et al.* 1989B: Van Heerden *et al.* 1985C: Okotie-Eboh *et al.* 1992D: Palomeque *et al.* 1991

rals zinc, copper, calcium, phosphorus, magnesium and manganese (Gandini *et al.* 1986). Compensatory elevations in the serum levels of these minerals may account for the disparity between results of the present study and those reported by Van Heerden *et al.* (1985); Levy *et al.* (1989); Okotie-Eboh *et al.* (1992) and Bezuidenhout, Burger, Reyers & Soley (1994). Physiological factors such as age and sex are

also known to influence these parameters (Mori & George 1978). It should be pointed out that the level of manganese was at the lower end of the detection limit and as such they may not be consistently accurate.

Activity due to serum AP was comparable to that reported by Levy *et al.* (1989) and Van Heerden *et al.*



(1985), but was twice as high as that obtained by Okotie-Eboh *et al.* (1992). Elevations may be due to physiological increase in osteoclastic activity typical of normal bone growth.

The range of enzyme activity due to creatinine kinase was comparable to the values reported by all the authors, except Okotie-Eboh *et al.* (1992).

The discrepancies in the levels of the CK could be attributed to increased muscular activity as a result of the birds' struggling while being restrained during the bleeding process (Spano, Pedersoli, Kempainen, Krista & Young 1987). This enzyme, in addition to GT, is found in high concentration in skeletal for the high levels of GT were obtained even in the repeat determinations.

Levels of the total protein, as well as albumin, were higher in this study than the values mentioned by Levy *et al.* (1989); Van Heerden *et al.* (1985); Palomeque *et al.* (1991) and Okotie-Eboh *et al.* (1992) in contrast to levels of uric acid, total bilirubin, glucose and cholesterol which were lower in this study.

Palomeque *et al.* (1991) reported urea values higher than those in the present study although they were within the same general range. According to Sturkie (1965), high blood urea in ostriches and birds in general may result if they ingest large quantities of animal protein. Also catabolism of body protein as in dietary deficiency in essential amino acids may elevate levels of urea. Considering that free-living ostriches are herbivores and these ostriches were not fed animal protein, elevation in urea levels was paradoxical.

Birds are uricotelic and produce uric acid as the major nitrogenous end-product of the metabolism of protein (Lewandowski, Campbell & Harrison 1986). It has been suggested that blood levels of uric acid increase in animals fed on a high animal protein diet (Bell & Sturkie 1965). Low uric acid levels were anticipated in this study since ostriches are herbivores and the ostrich feed did not contain any animal protein.

Cholesterol levels in this study were 50% lower than those reported in other studies. This variation can be attributed to variations caused by circadian rhythms as described for certain other bird species (Garcia-Rodriguez, Ferrer & Recio, Castroviejo 1987) or diet (Mori & George 1978) for it is known that higher levels of fat and low protein may result in high serum cholesterol and vice-versa (Perry, Obrecht, Williams & Kunzel 1986).

Low plasma glucose levels could have been as a result of rapid utilization by the erythrocytes (Dolnik 1973). In birds, variation in the level of this metabolite may also be a consequence of the absorptive rate of the bird. Seasonal variations of glucose have also

been described in the songbird, *Silvia borin* (Bairelein 1983). Ostriches might possibly follow a similar trend.

While the serum creatinine figures obtained were comparable to those given by Levy *et al.* (1989), they were lower than values reported by Van Heerden *et al.* (1985); Okotie-Eboh *et al.* (1992) and Palomeque *et al.* (1991). Variations in the concentrations of creatinine, an indicator of renal integrity can be explained in terms of its relation with diet (Woerpel & Roskopf, 1984). Various bird species fed on a diet containing animal protein had higher levels of creatinine than those not receiving such protein.

The mean levels of triglycerides in the present study were comparable to those reported for ostriches by Levy *et al.* (1989). It is suggested that this discrepancy can be attributed to differences in the diet of ostrich populations under different animal husbandry practices.

The concentrations of the various analytes presented in this study may be used as a guideline for baseline values of adult farmed ostriches in Botswana, irrespective of sex and animal husbandry practices. The results can also form a basis for future investigations pertaining to these analytes.

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## REFERENCES

- BAIRELEIN, F. 1983. Seasonal variations of serum glucose levels in a migratory songbird, *Silvia borin*. *Comparative Biochemistry and Physiology*, 76:397-399
- BELL, D.J. & STURKIE, P.D. 1965. Chemical constituents of blood, in *Avian physiology*, 2<sup>nd</sup> ed., edited by P.D. Sturkie. Ithaca: Comstock Publications Associate Division, Cornell University Press: 32-84.
- BEZUIDENHOUT, A.J., BURGER, W.P. REYERS, F. & SOLEY, J.T. 1984. Serum and bone mineral status of ostriches with tibio-tarsal rotation. *Onderstepoort Journal of Veterinary Research*, 61:203-206.
- BRUGUERE-PICOUX, J., BRUGUERE, H., BASSET, I., SAYAD, N., VAAST, J. & MICHAUX, J.M., 1987. Biochemie clinique en pathologie aviaire. Interet et limites des dosages enzymatiques chez la poule. *Recueil Medicine Veterinari*, 63:1091-1099.
- CAMPBELL, T.W. & COLES, E.H. 1986. Avian clinical pathology, in *Veterinary clinical pathology*, 4<sup>th</sup> ed., edited by E.H. Coles. Philadelphia: W.B. Saunders: 270-301.
- DOLNIK, T.V. 1973. Diurnal and seasonal cycles of the blood sugar in sedentary and migrating birds. *Zoologicheskii Zhurnal*, 52:94-103.
- GANDINI, G.C.M., BURROUGHS, R.E.J. & EBEDS, H. 1986. Preliminary investigations into the nutrition of ostrich chicks

- (*Struthio camelus*) under intensive conditions. *Journal South African Veterinary Association*, 67:39–42.
- GARCIA-RODRIGUEZ, T.M., FERRER, F., RECIO, CASTRO-VIEJO, J. 1987. Circadian rhythms of determined blood chemistry values in buzzards and eagle owls, *Comparative Biochemistry and Physiology*, 88A:663–669.
- KANEKO, J.J. 1989. Serum proteins and disproteinemia, in *Clinical biochemistry of domestic animals*, edited by J.J. Kaneko. 4<sup>th</sup> ed. San Diego: Academic Press Inc.: 142–165.
- KENNY, A.D. 1986. Parathyroid and ultimobranchial glands, in *Avian physiology*, 4<sup>th</sup> ed., edited by P.D. Sturkie. New York: Springer-Verlag: 466–493.
- LEVY, A., PERELMAN, B., WANER, T., GREVENBROEK, M., VAN CREVELD, C. & YAGIL, R., 1989. Reference blood values in ostriches (*Struthio camelus*). *American Journal Veterinary Research*, 50:1540–1550.
- LEWANDOWSKI, A.H., CAMPBELL, T.W. & HARRISON, G.J. 1986. Clinical Chemistries, in *Clinical avian medicine and surgery*, edited by G.J. Harrison & L.R. Harrison. Philadelphia: W.B. Saunders: 192–200.
- MORI, J.G. & GEORGE, J.C. 1978. Seasonal changes in serum levels of certain metabolites, uric acid and calcium in the migratory Canada goose (*Branta canadensis interior*) *Comparative Biochemistry and Physiology*, 59B:263–269.
- OKOTIE-EBOH, G., BAILEY, C.A., HICKS, K.D. & KUBENA L.F. 1992. Reference serum biochemical values for emus and ostriches. *American Journal Veterinary Research*, 53:1765–1768.
- PALOMEQUE, J., PINTO, D. & VISCOR, G. 1991. Haematologic and blood chemistry values of the Masai ostrich (*Struthio camelus*). *Journal of Wildlife Diseases*, 27:34–40.
- PERRY, M.C., OBRECHT, H.H., WILLIAMS, B.K. & KUNZEL, W.J. 1986. Blood chemistry and haematocrit of captive and wild canvas backs. *The Journal of Wildlife Management*, 50: 435–444.
- SPANO, J.S., PEDERSOLI, W.M., KEMPPAINEN, J.J., KRISTA, L.M. & YOUNG, D.W. 1987. Baseline haematologic, endocrine and clinical chemistry values in ducks and roosters. *Avian Diseases*, 31:800–803.
- STOSKOPF, J.J., BEALL, F.B., ENSLEY, P.K. & NEELY, E. 1982. Immobilization of large ratites: blue necked ostrich (*Struthio camelus australis*) and double wattled cassowary (*Casuaris casuaris*) with haematologic and serum chemistry data. *Journal Zoo Animal Medicine*, 13:160–168.
- STURKIE, P.D. 1965. Kidneys and urine, in *Avian physiology*, 2<sup>nd</sup> ed., edited by P.D. Sturkie. Ithaca: Comstock publication Associates, Cornell University Press: 372–405.
- VAN HEERDEN, J., DAUTH, J., JARVIS, M.J.F., KEFFEN, R.H., DENNY, J.E.F.M., DREYER, M.J. & KRIEK, P.J. 1985. Blood biochemical and electrolyte concentrations in the ostrich (*Struthio camelus*). *Journal South African Veterinary Association*, 56:75–79.
- WOERPEL, R.W. & ROSSKOPF, W.J. 1984. Clinical experience with avian laboratory diagnostics. *Veterinary Clinics of North America Small animal Practice*, 124:249–272.