

Selected hematologic values of farmed ostriches (*Struthio camelus*) in Botswana

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The ostrich (*Struthio camelus*) industry in Botswana is still young, and as such, there is scant information on hematology of the ostrich. Veterinary clinical hematology is a useful tool for the diagnosis of disease in both domestic mammals and birds.^{1,22} Hematologic values of the Masai ostrich (*Struthio camelus massaicus*) were reported as early as 1875.² The physical properties of ostrich blood cells have been extensively described.^{2,12,13,18,20} Although clinical hematology is a useful diagnostic tool in avian medicine,^{21,22} interpretation is dependent on established baseline levels for the species. Furthermore, these parameters may be influenced by climatic conditions prevalent in the particular geographic location and by different management systems. The purpose of this study was to establish baseline hematology values for juvenile and adult farmed ostrich in Botswana.

One hundred ostriches, 50 juveniles (1–10 months of age) and 50 adults (11–18 months of age), were maintained in fenced pens. The ostriches were separated according to age. The diet consisted mainly of commercial ostrich pellets. Chopped fresh lucerne plus vitamin and mineral supplements were often added to the diet. Grit in the form of ground stones was added to the feed. Water was available ad libitum. The birds were apparently healthy, with no signs of disease.

For blood collection, black hoods made of translucent muslin cloth were placed over the heads of adult ostriches to avoid stress. The younger birds were gently restrained on a table without the hood. Blood was obtained by venipuncture from the brachial (wing) vein after cleansing the area with an antiseptic.^a A sterile cotton swab soaked in 70%

ethanol was used to slightly dilate the vein. Blood was collected into heparinized vacutainer tubes. Blood for examination of erythrocyte sedimentation rates was collected in sodium citrate. All laboratory examinations were carried out within 4 hours of sample collection.

Hemoglobin (Hb) was determined colorimetrically in a hemoglobinometer^b using the principle of cyanmethemoglobin release.⁹ Six drops of lysing solution^b were dispensed in the diluted blood for 30 minutes, after which the cyanmethemoglobin reagent–blood mixture was centrifuged at 30,000 × g for 10 minutes to remove the cell debris and the nuclei, which would interfere with spectrophotometric transmission.

The packed cell volume (PCV) was determined using a hematocrit centrifuge^c at 10,000 × g for 5 minutes. The total red blood (TRBC) and total white blood cell (TWBC) counts were determined using Natt Herrick diluent^d as previously described.²¹ The differential white cell count was determined by fixing air dried monolayers of blood for 3 minutes using the Leishman/Wright stain.^d The staining was completed by addition of a phosphate buffer (pH 6.8)^d and then staining for 6 minutes. Stain was washed off gently with running tap water, and the slide was dried and then examined in a light microscope. The white cells were classified as previously described.¹⁴

The calculated erythrocyte indices of mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were determined by the standard formulas.⁹ The erythrocyte sedimentation rate (ESR) was determined as previously described^{9,10} over a period of 6 hours using citrated blood in Wintrobe tubes^d held vertically. Average erythrocyte and erythrocyte nucleus length and width were measured from 50 selected smears that were fixed with methanol and stained

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Table 1. Hematologic parameters of ostriches in Botswana.

Parameters	Adult ($\bar{x} \pm SD$)	Juvenile ($\bar{x} \pm SD$)
Red blood cell count ($\times 10^{12}$ /liter)	2.1 ± 0.2	1.8 ± 0.2
Hemoglobin (g/dl)	16.68 ± 0.93	10.9 ± 1.2*
Packed cell volume (%)	43.25 ± 1.9	36 ± 1.2*
Mean corpuscular volume (fl)	205.95 ± 15.0	200 ± 18.0
Mean corpuscular hemoglobin (pg)	79.42 ± 12	60.56 ± 5.0*
Mean hemoglobin concentration (g/dl)	38.56 ± 2.0	30.28 ± 1.5*
Total leukocyte count ($\times 10^9$ /liter)	5.0 ± 1.8	3.8 ± 1.7
Heterophil (H) (%)	60 ± 2.1	62 ± 1.2
Lymphocyte (L) (%)	32 ± 2.0	29 ± 1.6
H/L ratio	1:2	...
Eosinophils (%)	1 ± 0.2	1 ± 0.2
Monocytes (%)	1 ± 0.5	1 ± 0.6
Basophils (%)	6 ± 1.4	7 ± 1.4
Thrombocyte count ($\times 10^9$ /liter)	0.2	0.2

* Values within rows are significantly different ($P < 0.05$).

Table 2. Measurements of erythrocytes in 5 adult and 5 juvenile ostriches.

Measurement	Adults		Juveniles	
	$\bar{x} \pm SD$	Range	$\bar{x} \pm SD$	Range
Cell length (μm)	16.24 ± 0.84 (13.30 ± 1.09)*	15.75–18.00	16.5 ± 0.7 13.18 (1.17)*	15.9–18.00
Cell width (μm)	11.3 ± 0.78 (7.53 ± 0.79)*	9.0–12.38	11.4 ± 0.8 (7.49 ± 0.84)*	10.0–13.0
Cell length/cell width	1.47 ± 0.12 (1.77 ± 0.19)*	1.4–1.5	1.49	1.4–1.5
Nucleus length (μm)	5.45 ± 1.05 (5.58 ± 0.72)*	5.06–7.88	5.6 ± 1.0 (5.47 ± 0.67)*	5.1–8.0
Nucleus width (μm)	3.62 ± 0.67 (2.96 ± 0.48)*	2.84–4.5	3.6 ± 0.60 (2.89 ± 0.40)*	2.82–4.7
Nucleus length/width	1.50 ± 0.1 (1.89 ± 0.41)*	1.45–1.6	1.8 ± 0.5 (1.9 ± 0.37)*	1.6–1.9

* Values obtained by Palomeque et al.¹⁸ for comparison.

with May Grunwald and Giemsa solutions^d using standard techniques.¹⁴ The cells were examined at 1,000×, and their dimensions were estimated using a calibrated eyepiece^e as described.⁵ Fifty erythrocytes were measured on smears selected for excellence of staining and internal cytology. Ratios of maximum length to width were calculated as an index of the deviation of the erythrocytes from a spherical shape. Significant differences ($P < 0.05$) between means were determined using Student's *t*-test.

Table 1 shows values of hematologic parameters of adult and juvenile ostriches. PCV Hb, and TRBC values were lower for juvenile ostriches than for adults. These results have been observed previously in ostriches,^{13,18} rosy flamingos (*Phoenicopiterus ruber ruber*) and Chilean flamingos (*P. chiliensis*),^{6,7} and domestic fowl.¹⁷ The calculated MCV, MCH, and MCHC values were also lower in the juveniles than in the adults. Hypochromia was evident. All the hemogram parameters in this study were lower than those reported for adult Masai ostriches¹⁸ but were within the same range as those for the rosy flamingo.¹⁹

Table 2 shows measurements of erythrocytes in adult and juvenile ostriches. Most of the morphometric values in both groups of ostriches in this study were higher than values reported by others¹⁸ except for the ratio of nucleus length to nucleus width, which was higher in the present study.

Age-related increases in Hb levels up to adulthood have

Table 3. Mean (±SD) erythrocyte sedimentation rates (ESR) for clinically normal ostriches over a period of 6 hours. All differences between juveniles and adults were significantly different ($P < 0.05$) each time.

Time (hr)	Juveniles	Adults
1	2.5 ± 0.5	1 ± 0.5
2	6 ± 1.0	3 ± 0.5
3	7 ± 2.5	4 ± 0.3
4	8 ± 2.4	4 ± 0.5
5	14 ± 3.0	4 ± 0.5
6	16 ± 2.5	4 ± 0.3

been demonstrated in birds,¹³ and lower PCV in canvasback (*Aythya valisineria*) ducklings versus ducks have been reported.¹¹ Female guinea fowls (*Numida meleagris*) at 8 weeks of age reportedly had significantly lower PCVs than did females of other age groups.³ The increase in Hb concentration could be due to changes in blood volume/unit body weight;¹⁶ however, this age-related hematologic difference does not seem to be characteristic of all avian species.⁴

The TWBC count for the ostriches in this study were similar to those in ostriches in previous studies² and to those listed for other bird species.¹² The TWBC counts were higher in juvenile ostriches than in adults, a finding contrary to the observations of other workers.¹³ This difference may have been due to variation among ostriches in cellular response to the stress of handling.¹⁵ The individual white cell types in the differential cell counts did not show any particular trends.

The results of the ESR calculations are presented in Table 3. There was a steady increase in the ESR in the juveniles during 6 hours of the test, but the sedimentation rate was static after 4 hours for blood from the adults. Thus, ESR may be a useful diagnostic tool for ostriches, as previously suggested,¹³ in contrast to the situation for flamingos⁷ and cranes,⁸ in which the ESR was of no clinical value because the erythrocytes of these birds failed to sediment when either healthy or diseased. Physiochemical properties of plasma and of erythrocyte surfaces influence the sedimentation rate. Some of these factors have yet to be investigated in ostriches and an understanding of them would facilitate interpretation of ESR results.

Hematologic values obtained in this study will assist researchers in establishing reference values for farmed ostriches in Botswana and other countries.

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Sources and manufacturers

- a. Savlon, Johnson and Johnson, South Africa.
- b. Coulter Electronics, Hialeah, FL, USA.

- c. Clements, Sydney, Australia.
- d. Merck, Johannesburg, South Africa.
- e. Nikon, Tokyo, Japan.

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An outbreak of enterocolitis due to *Campylobacter* spp. in a beagle colony

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Over a 6-week period in spring 1997, 8 beagle dogs from a commercial colony were presented to the Athens Veterinary Diagnostic Laboratory with a history of chronic diarrhea and failure to thrive. Animals ranged in age from 6 weeks to 8 months and included both males and females. All 8 animals were in poor body condition, with rough hair coats. Gross intestinal abnormalities were noted in all, with the most frequent finding being flaccid small and large intestines containing frothy, malodorous, and sometimes mucoid ingesta. Histologically, all had similar changes in the

small intestine, with the most dramatic changes noted in the distal jejunum and ileum. Changes included varying degrees of fusion or blunting of villi, rare evidence of crypt epithelial cell degeneration, and lymphoplasmacytic infiltrates in the lamina propria. Colons were examined histologically from only 7 of the 8 dogs. Changes consisted of superficial erosions, increased numbers of lymphocytes and plasma cells in the lamina propria, varying degrees of crypt epithelial hyperplasia, and occasional crypts packed with filamentous bacteria that became more evident with silver staining (Fig. 1).

A variety of ancillary diagnostic tests were performed (Table 1). All 8 dogs were negative by fluorescent antibody (FA) testing for canine parvovirus and canine distemper virus. One (dog 4) of the 8 dogs was positive by FA for canine coronavirus; all others were negative. An FA test for *Cryp-*

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