

Harris's hawks (*Parabuteo unicinctus*) hematological parameters in different tropical locations

José Antonio Herrera-Barragan¹, Fernanda Rodriguez-Hernandez¹, Ricardo Camarillo-Flores², Gustavo Ernesto Quintero³, Fernando Gual-Sill¹, Juan José Perez-Rivero^{1*}

¹ Department of Agricultural and Animal Production, Metropolitan Autonomous University, Mexico City, Mexico; ² Department of Biology, Autonomous Metropolitan University, Iztapalapa, Iztapalapa, Mexico; ³ Department of Biology, Autónoma University of Aguascalientes, Aguascalientes, Mexico.

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Abstract

This work described and compared the hematological findings of 25 clinically healthy Harris's hawks (*Parabuteo unicinctus*) in captivity at two different tropical locations: 16 samples from Aguascalientes, which altitude is 1878 mean sea level, and nine samples from Amecameca which altitude is 2650 mean sea level. Blood samples were collected from the brachial vein of each raptor under physical restraint. Significant differences between the two locations were found in some parameters including total, erythrocytes, heterophils, basophils, lymphocytes, and heterophil/lymphocyte ratio. When the results were compared to the reference values, the population of Amecameca showed decreased values of hematocrit ($32.21 \pm 13.72\%$), hemoglobin ($107.40 \pm 45.60 \text{ g L}^{-1}$) and erythrocytes ($1.98 \pm 0.63 \times 10^{12}$ per μL). This work contributed to the knowledge of variations in blood parameters of clinically healthy captive Harris's hawks at different tropical locations and sex. The information will enable clinicians to provide appropriate veterinary diagnostics and care to ensure the health and welfare of raptors kept in captivity.

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Introduction

Birds of prey possession and training have been documented since ancient times mainly for falconry purposes. Some areas of interest include veterinary and health aspects with the special interest in taxonomic groups such as falconiforms and strigiforms.¹

Nowadays an important aspect of conservation of raptors and their legal protection involves health issues, which include the development of preventive medicine programs and the early detection of diseases.^{2,3}

Experimental studies have shown that different infections in wild birds are asymptomatic, however, this condition does not prevent disease-causing agents from being excreted. For this reason it is important to perform diagnostic tests such as the blood count to determine the health status of each individual when are referred to the rehabilitation centers, shelters or collections.⁴⁻⁷

Furthermore, some atmosphere conditions such as altitude among sea level, modify the relation between oxygen availability and hematological parameters.⁸ Native high-altitude birds have a higher concentration of hemo-

globin, red blood cell count, and hematocrit percentage.⁹ However, these differences are also associated with various physiological conditions such as physical activity, age, weight, gender and nutrition.⁸

Taking all these aspects into account, this study aimed to describe and compare hematological parameters and total proteins of two captive raptor populations of the same species at different tropical locations and altitudes.

Materials and Methods

A transversal study was conducted in two different tropical locations and altitudes in Mexico: Aguascalientes ($21^{\circ}51'05.3''\text{N}$, $102^{\circ}17'14.6''\text{W}$) which altitude is 1878 MSL; according to Köpen and Geiger its climate is classified as tropical steppe climate (BSh), its mean temperature is 18.00°C and mean annual rain is 533 mm. Amecameca ($19^{\circ}08'30.0''\text{N}$ $98^{\circ}46'17.9''\text{W}$), which altitude is 2650 MSL, classified as subtropical highland climate (Cwb) in Köpen and Geiger's system, its mean temperature is 14.30°C and mean annual rain is 924 mm. This study was performed under the Official Mexican Standard NOM-062-ZOO-1999,

*Correspondence:

Juan José Perez-Rivero. PhD

Department of Agricultural and Animal Production, Metropolitan Autonomous University, Mexico City, Mexico

E-mail: jperezr@correo.xoc.uam.mx



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technical specifications for the production, care and use of laboratory animals.

Two private collections were visited, using the whole populations of each one, with 25 clinically healthy Harris's hawks *Parabuteo unicinctus* in captivity: Aguascalientes (n = 16), where hawks were not trained and physical activity was limited and Amecameca (n = 9), where hawks were trained and physical activity was unlimited.

Blood samples (0.50 mL) were collected from the brachial vein of each hawk placed in dorsal decubitus position under physical restraint using a 26 gauge needle as described by Solari *et al.*¹⁰ All samples were taken at 9:00 am and before any kind of training. With the blood obtained from each hawk, a heparinized capillary tube was filled to determine hematocrit. The average corpuscular volume (VCM) was obtained by dividing the hematocrit between the erythrocyte counts and multiplying by 10. Later, leukocytes concentration was determined using the objective 10x of the microscope, counted the total number of white blood cells (WBC) in the large squares located in the four corners of the Neubauer chamber. To determine the quantity of the red blood cells (RBC), the 40x objective was used to count the cells in the four corners and the center of the central square of the Neubauer chamber.

Subsequently, a blood smear was performed, which was stained with DiffQuick™ (DQ-ST; Microptic, Barcelona, Spain) to determine the differential parameters of erythrocyte and leukocytes,¹¹⁻¹⁵ and finally, an *in vitro* diagnostic device hemochroma PLUS™ (Boditech Med Inc., Chuncheon-si, South Korea) was used to quantitatively determine total hemoglobin. A Biuret method was performed to determine total protein.¹²

Study groups were assessed by place and sex, the normality of the variables was determined with the Shapiro Wilk test. Data were compared to descriptive statistics including mean, standard error (SE) and quartile (Q). Mann-Whitney Wilcoxon tests were performed to compare the averages of both locations and the sex. A $p < 0.05$ was considered significant using Past Software (PAleontological STatistics, Oslo, Norway).¹⁶

Results

Decreased total protein, heterophils, basophils, and heterophil to lymphocyte ratio values were found in Harris's hawks located in Aguascalientes when compared to individuals located in Amecameca. In the latter location, lower values of lymphocytes were found ($p < 0.05$). Nevertheless, comparing the results to the reference values, it was found that that hawks in Amecameca showed low levels of erythrocytes and hemoglobin, and in the population, monocytosis was also detected, which was considered a hallmark of chronic infection (Table 1). The females showed a significant difference ($p < 0.05$) in the level of total protein compared to the male hawks (Table 2).

Discussion

Both populations were in different conditions of altitude, climate, and physical activity, is this last one of the most important, and the hawks in Amecameca were trained permanently, while in Aguascalientes physical activity was limited.

Since the values of hematocrit, hemoglobin and the erythrocytes count were below the reference values reported by Parga *et al.*, it was suggested subclinical anemia in the animals, due to the daily training and inadequate nutrition to cover the requirements that the physical activity requires.⁷

In this study, the values of MCV were elevated in both populations, which was consistent with the findings of Galvez *et al.* that found differences in the MCV values. This parameter is highly related with the specific physical activity from each species.¹¹

In a study conducted by Parga *et al.*, the hematological evaluation was performed in Harris hawks in training and monocytosis was detected, It was associated with an increase in physical activity, a similar situation to the one found in the population of Amecameca.⁷

Considering that there are some limitations such as sample size, this work contributed to the knowledge of

Table 1. Comparison of hematologic values between locations. SE: standard error and Q: quartile.

Parameters	Amecameca (n=9)				Aguascalientes (n=16)				p-value
	Mean ± SE	Q1	Q2	Q3	Mean ± SE	Q1	Q2	Q3	
Hematocrit (%)	32.21 ± 13.72	23.50	29.43	41.51	35.70 ± 6.30	32.50	37.20	39.30	> 0.05
Hemoglobin (g L ⁻¹)	107.40 ± 45.60	76.70	98.00	138.50	119.10 ± 21.10	108.40	124.10	131.00	> 0.05
Mean corpuscular volume (fl)	170.00 ± 0.60	130.00	160.00	180.00	150.00 ± 10.00	90.00	120.00	120.00	> 0.05
Erythrocytes (×10 ⁶ μL ⁻¹)	197.80 ± 63.80	130.00	192.00	254.00	279.80 ± 88.30	243.00	284.00	342.00	> 0.05
Total protein (g dL ⁻¹)	5.10 ± 1.30	4.00	5.00	6.50	2.90 ± 0.40	2.60	3.00	3.20	< 0.05
Thrombocytes (%)	8.00 ± 1.73	6.50	8.00	9.50	10.40 ± 5.50	6.30	9.50	11.80	> 0.05
Leukocytes (×10 ⁶ μL ⁻¹)	5.11 ± 2.20	3.00	5.00	6.00	5.00 ± 2.20	3.00	4.50	6.00	> 0.05
Heterophils (%)	31.20 ± 8.70	25.50	31.00	34.50	5.00 ± 2.40	3.00	5.00	7.00	< 0.05
Eosinophils (%)	13.20 ± 8.10	6.50	14.00	20.50	14.00 ± 9.80	7.50	10.50	16.00	> 0.05
Basophils (%)	18.40 ± 11.60	11.00	16.00	21.00	6.00 ± 3.40	4.00	6.00	7.50	< 0.05
Monocytes (%)	7.60 ± 3.80	5.00	7.00	9.50	13.30 ± 10.50	7.00	8.00	18.20	> 0.05
Lymphocytes (%)	23.80 ± 11.60	15.00	21.00	34.00	51.10 ± 18.00	31.30	60.00	66.50	< 0.05
Heterophils/Lymphocytes ratio	1.80 ± 1.50	0.70	1.60	2.15	0.10 ± 0.10	0.10	0.10	0.10	< 0.05

Table 2. Comparison of hematologic values between genders. SE: standard error and Q: quartile.

Parameters	Male (n=13)				Female (n=12)				p-value
	Mean ± SE	Q1	Q2	Q3	Mean ± SE	Q1	Q2	Q3	
Hematocrit (%)	36.40 ± 11.50	26.80	37.20	43.50	32.40 ± 6.60	27.00	34.00	38.00	> 0.05
Hemoglobin (g L ⁻¹)	121.30 ± 38.50	89.40	124.00	145.10	108.00 ± 22.00	90.20	113.00	125.60	> 0.05
Mean corpuscular volume (fl)	140.00 ± 60.00	120.00	130.00	170.00	160.00 ± 1.00	90.00	130.00	190.00	> 0.05
Erythrocytes (×10 ⁶ μL ⁻¹)	246.20 ± 67.00	200.00	268.00	288.00	255.00 ± 110.00	141.00	266.00	342.00	> 0.05
Total Proteins (g dL ⁻¹)	43.00 ± 15.00	33.00	34.00	55.00	30.00 ± 10.00	25.00	29.00	31.00	< 0.05
Thrombocytes (%)	9.30 ± 4.10	6.50	9.00	10.00	9.80 ± 5.30	6.20	9.50	10.80	> 0.05
Leukocytes (×10 ⁶ μL ⁻¹)	5.00 ± 3.00	2.50	4.00	8.50	4.00 ± 1.20	3.00	3.50	5.00	> 0.05
Heterophils (%)	19.00 ± 16.00	18.00	3.50	32.00	9.60 ± 9.80	3.50	7.00	9.00	> 0.05
Eosinophils (%)	13.80 ± 6.60	10.00	15.00	18.50	13.60 ± 11.50	6.30	10.00	15.80	> 0.05
Basophils (%)	11.00 ± 6.40	5.50	10.00	16.50	10.00 ± 12.20	4.00	6.00	10.00	> 0.05
Monocytes (%)	12.20 ± 11.4	5.00	8.00	13.00	10.30 ± 6.00	7.00	7.50	14.00	> 0.05
Lymphocytes (%)	35.00 ± 21.8	19.00	27.00	54.00	48.10 ± 17.70	31.30	51.00	61.8	> 0.05
Heterophils/Lymphocytes ratio	1.10 ± 1.50	0.10	0.70	1.80	0.10 ± 0.10	0.10	0.10	0.10	> 0.05

variations in blood parameters of clinically healthy captive Harris's hawks at different tropical locations and sex.¹⁷

Further research is needed to fully examine the birds of prey hematology and to expand these studies to chemistry profiles. These findings will enable bird clinicians to provide proper veterinary care to ensure the health and welfare of an increasing number of raptors kept in captivity for different reasons including falconry, rehabilitation, and conservation purposes.

Conflict of interest

The authors declared that there were no conflicts of interest related to this article.

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