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Source: Journal of Wildlife Diseases, 17(1) : 135-143

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-17.1.135

HEMATOLOGY AND SERUM CHEMISTRY VALUES FOR CAPTIVE DORCAS GAZELLES: VARIATIONS WITH SEX, AGE AND HEALTH STATUS

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Abstract: Blood samples obtained from 55 captive Dorcas gazelles *(Gazella dorcas)*, collected over a 9-year period, were analyzed for hematology and serum chemistry values. Variations associated with differences in sex, age, and health-status were identified.

INTRODUCTION

There is relatively little information available concerning normal blood parameters of captive wild animals and data are particularly lacking for members of the genus *Gazella* (Artiodactyla:Bovidae). Baseline laboratory data for captive Grant's gazelles *(Gazella granti)* have been given by Seal and Schobert,[10] and Drevemo *et al.*[3] have reported on blood parameters in shot wild Grant's and Thomson's gazelles *(Gazella thomsonii)*.

As part of an ongoing medical care program, blood data have been collected over a 9-year period from a herd of Dorcas gazelles *(Gazella dorcas)* maintained at the National Zoological Park in Washington, D.C. This actively reproducing herd has provided the opportunity to establish clinicochemical profiles for this species and to evaluate the variations in hematologic and serum chemistry values associated with sex, age, and health status.

MATERIALS AND METHODS

Blood samples were collected from 55 individual Dorcas gazelles ranging in age from several hours to greater than 20 years. During the study period, the herd of gazelles varied in size from 6 to 16 animals. They were moved from their original fenced yard of approximately 800 m^2 to a larger yard of about 3,000 m^2 during the second year of the study period. Their diet consisted of commercial preparations [1] [2] and alfalfa and timothy grasses. Water was available for use *ad libitum*.

As part of a preventative medical program, each of the gazelles was periodically restrained manually and given an antihelminthic preparation by stomach tube. On these occasions, blood samples were collected for clinicochemical and acid-base analysis, and the respiration rate, heart rate, and rectal temperature were measured. In addition, upon the birth of an animal, blood samples were taken within 24 hours for

[1] Horse Chow Checkers, Ralston Purina Co., St. Louis, Missouri.

[2] Omolene, Ralston Purina Co., St. Louis, Missouri.

hematologic and serum chemistry evaluation. The above procedures provided more than 80% of the data collected during this study and were considered representative of normal, healthy animals. These data were grouped and evaluated for variations relating to differences in age and sex. Three age groups were used: neonatal (up to 1 month old); juvenile (from 1 month old to 1 year old); and, adult (more than 1 year old). Due to the length of the study period, some individual animals provided data to more than one age group.

The remaining blood data were obtained from samples of Dorcas gazelles undergoing treatment or observation for clinical problems. These data were arbitrarily categorized into one of four diagnostic or abnormal health groups. The four groups included: acute trauma group (samples obtained from animals with fractures, lacerations, etc.); abscess group (samples obtained from animals with diagnosed or visible abscesses); post-surgical group (samples obtained from animals during surgical recovery, primarily following Caesarian sections); and, non-specific diagnosis group (samples obtained from animals with undiagnosed problems but showing clinical signs of disease such as rough hair coat, anorexia, or general depression).

Blood samples were collected from the jugular vein with large-volume, plastic disposable syringes. The samples were immediately transferred to 2-ml glass tubes containing the anticoagulant ethyldiaminetetraacetic acid (EDTA) for hematologic evaluation, and to 10-ml silicone-coated glass tubes without anticoagulant for serum chemistry tests.

During the 9-year study period, several of the laboratory procedures were changed. Originally, the white blood cell count (WBC) and the red blood cell count (RBC) were performed manually.[3] For the last 6 years, however, these determinations have been made with an electronic cell counter.[4] The anticoagulant used for the hematology work has been changed from heparin to EDTA. Hemoglobin concentrations have been measured with a cyanomethemoglobin procedure continuously, but the original manual technique has been replaced with an automated method.[5]

Other laboratory procedures remained constant. Hematocrit values were obtained using a microhematocrit centrifuge technique. Total plasma protein (TP) was measured with a refractometer.[6] Values for mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were calculated with standard equations using the determined values for hematocrit, hemoglobin, and RBC. Serum levels of calcium, phosphorus, glucose, urea nitrogen (BUN) uric acid, cholesterol, total bilirubin, alkaline phosphatase, lactic dehydrogenase (LDH), and serum glutamic-oxaloacetic transaminase (SGOT) were determined with an autoanalyzer.[7] Sodium and potassium concentrations were measured with a flame photometer[8] and chloride concentrations were determined with an automated method.[9]

[3] Unopette, Becton-Dickinson, Rutherford, New Jersey.

[4] Coulter counter ZBI6, Coulter Diagnostics, Hialeah, Florida.

[5] Coulter Hemoglobinometer, Coulter Diagnostics, Hialeah, Florida.

[6] Goldberg Refractometer, American Optical Co., Instruments Div., Buffalo, New York.

[7] SMA/12, Technicon Instruments Corp., Chauncey, New York.

[8] IL 343, Instrumentation Laboratories, Inc., Lexington, Massachusetts.

[9] SMA/6, Technicon Instruments Corp., Chauncey, New York.

On many occasions, jugular venous blood samples were also collected for pH and blood gas analysis. The samples were drawn anaerobically, using 1-ml disposable tuberculin syringes, from hand-restrained animals. After thorough mixing, the samples were introduced into a pH/blood gas analyzer [C] and values for pH, pCO_2, and pO_2 were recorded at the instrument's temperature of 37 C. When working in the field, or when the analyzer was not immediately available, the samples were placed in an ice bath and analyzed within 3 hours. The recorded pH values were corrected to correlate with the individual gazelles' body temperatures by subtracting 0.015 pH units per 1 C difference above the instrumental temperature of 37 C.[7] The pCO_2 and pO_2 values were temperature-corrected using line charts prepared for dogs and man.[11] Plasma bicarbonate concentrations (HCO_3) were calculated with an acid-base slide rule [D] and base excess (BE) was estimated on an alignment nomogram.[12]

The results from all blood testing were entered onto standard optiscan sheets and analyzed with a 6020 series Honeywell computer. The programs CONDESCRIPTIVE and BREAKDOWN, from the SPSS statistical package of Nie *et al.*,[6] were used to compilate and describe the data. Confidence intervals of 95% were calculated separately. Student's 't' test was used for the statistical evaluation of the differences between means; $p < 0.01$ denoted significance. An analysis of the variance both within and between individual animals' data was performed using the equations of Davies.[2] Two-way ANOVA programs were used to analyze the effects of age and sex on the mean values.

RESULTS

Baseline hematologic and serum chemistry values for Dorcas gazelles are described in Tables 1 and 2, respectively. The data presented are for animals of normal health status, of both sexes, and of all age groups. A wide range of values was seen in most measures. The greatest variations were seen for glucose, alkaline phosphatase, LDH, and SGOT.

Venous blood gas and acid-base values of normal Dorcas gazelles are given in Table 3, along with simultaneously measured physiological parameters. In general, all values displayed wide variation.

Sex-specific variations in the hematologic and serum chemistry values of normal Dorcas gazelles were found for several parameters (Table 4). Males had significantly higher values for hematocrit, hemoglobin, RBC, and glucose.

Considerable variation relating to age was found in the clinicochemical profiles of Dorcas gazelles (Table 5). Significant differences between the neonatal, juvenile, and adult groups were noted for hemoglobin, MCH, TP, calcium, phosphorus, cholesterol, total bilirubin, alkaline phosphatase, and LDH. Among the WBC, significant differences were also found for lymphocyte and eosinophil counts.

Many of the clinicochemical measures also showed significant variations from normal values with changes in health status (Table 6). Abnormal health states resulted in significantly lower hematocrit, hemoglobin, RBC, calcium, glucose, cholesterol, and alkaline phosphatase values. Values for WBC and MCH were increased above normal levels in the abnormal health groups. Neutrophil proportions increased, while

[C] IL 213 ph Blood Gas Analyzer, Instrumentation Laboratories, Inc., Lexington, Massachusetts.

[D] ph-Blood Gas Calculator, Instrumentation Laboratories, Inc., Lexington, Massachusetts.

lymphocyte, monocyte, eosinophil, and basophil proportions decreased, with abnormal health status.

DISCUSSION

A comparison of some clinicochemical values for Dorcas gazelles with those of

TABLE 1. Baseline hematologic values for Dorcas gazelles of normal health status.[a]

Parameter	No.	Range	Mean ± S.D.	95% Confidence Interval	
				Lower	Upper
Hematrocit, %	295	22.0-58.5	46.7±5.1	46.1	47.3
Hemoglobin, g/dl	270	7.1-21.5	16.3±1.9	16.1	16.6
RBC, $10^6/mm^3$	277	5.5-23.8	13.8±2.2	13.5	14.0
MCV, μ^3	275	20-85	34.5±5.6	33.8	35.2
MCH, $\mu\mu g$	264	7-17	12.0±1.6	11.8	12.2
MCHC, %	268	25-58	35.0±2.9	34.6	35.3
TP, g/dl	288	3.4-8.2	5.7±0.7	5.6	5.8
WBC, $10^3/mm^3$	293	2.3-18.1	6.2±2.6	5.9	6.5
Neutrophils, $10^3/mm^3$	263	0.1-6.1	3.9±2.4	3.6	4.2
Bands, $10^3/mm^3$	263	0.0-1.2	0.0±0.1	0.0	0.0
Lymphocytes, $10^3/mm^3$	263	0.1-2.4	2.1±1.2	2.0	2.3
Monocytes, $10^3/mm^3$	263	0.0-0.5	0.0±0.1	0.0	0.0
Eosinophils, $10^3/mm^3$	263	0.0-1.9	0.2±0.3	0.1	0.2
Basophils, $10^3/mm^3$	261	0.0-0.6	0.0±0.0	0.0	0.0

[a]Comprised of males and females of all age groups.

TABLE 2. Baseline serum chemistry values for Dorcas gazelles of normal health status.[a]

Parameter	No.	Range	Mean ± S.D.	95% Confidence Interval	
				Lower	Upper
Calcium, mg/dl	175	6.7-13.1	9.5±1.0	9.3	9.6
Phosphorus, mg/dl	173	1.0-14.5	7.0±2.3	6.6	7.4
Glucose, mg/dl	178	35-384	126±61	117	135
BUN, mg/dl	174	8-43	23±7	22	24
Uric Acid, mg/dl	174	0.0-1.1	0.3±0.2	0.2	0.3
Cholesterol, mg/dl	173	0-152	60±22	57	64
Total Bilirubin, mg/dl	171	0.1-0.9	0.2±0.1	0.2	0.2
Alkaline Phosphatase, IU/l	172	54-7600	327±640	231	422
LDH, IU/l	172	64-6100	763±558	679	846
SGOT, IU/l	172	80-1720	203±180	176	230
Sodium, mEq/l	35	102-170	151±13	147	156
Potassium, mEq/l	35	3.4-7.9	5.2±1.0	4.9	5.6
Chloride, mEq/l	36	105-136	113±5	111	114

[a]Comprised of males and females of all age groups.

TABLE 3. Venous blood gas, acid-base, and physiological values for Dorcas gazelles of normal health status.[a]

Parameter	No.	Range	Mean + S.D.	95% Confidence Interval	
				Lower	Upper
pH	87	7.03-7.51	7.27± .09	7.25	7.29
pCO_2, mmHg	87	25.2-70.2	41.3± 8.3	39.5	43.1
pO_2, mmHg	87	35.7-106.9	58.6±14.1	55.6	61.6
tCO_2, mEq/1	87	8.7-30.4	19.8± 4.7	18.8	20.8
HCO_3, mEq/1	87	7.7-28.8	18.5± 4.5	17.5	19.5
BE, mEq/1	66	<-20.0-+6.5	-7.7± 5.8	-9.12	-6.28
Pulse, beats/min	51	64-252	132.2±43.4	120.0	144.4
Respiration, breaths/min	54	16-132	49.6±20.7	43.9	55.3
Temperature, C	89	38.0-42.5	39.9± 0.8	39.7	40.1

[a]Comprised of males and females of all age groups.

other gazelle species is given (Table 7). Hematocrit and RBC values were slightly higher in the present study than those reported for both captive and shot Grant's gazelles[3,10] or for shot Thomson's gazelles.[3] Hemoglobin values were within the range reported for other species. The present study's TP and MCHC estimates were slightly lower than those given for captive Grant's gazelles, while the Dorcas gazelles' mean MCV values were higher. The WBC values of the present study were higher than those reported for the other gazelles.

The calcium values of the present study were similar to those of captive Grant's gazelles, while the values for both of these captive groups were lower than those given for shot animals. In contrast, the phosphorus concentrations of the two captive groups were higher than those reported for shot Grant's and Thomson's gazelles.

Captive Dorcas gazelles and captive Grant's gazelles had similar serum levels of BUN, sodium, and chloride. The Grant's gazelles had higher mean values for glucose, uric acid, cholesterol, and total bilirubin while the Dorcas gazelles had higher values for the enzymes alkaline phosphatase, LDH, and SGOT and slightly higher potassium concentrations.

Many of the differences seen between the gazelles of this study and those of other investigations may be attributed to differences in measuring techniques from study to study. This is especially likely in the serum chemistry values where a different procedure was used i

TABLE 4. Clinicochemical parameters for adult Dorcas gazelles showing si ficant ($p<0.01$) sex-specific variation.[a]

Parameter	Males		Females	
	n	Mean±S.D.	n	Mean±S.D.
Hematocrit, %	30	48.5±3.2	121	46.5±4.2
Hemoglobin, g/dl	29	17.4±1.4	109	16.4±1.7
RBC, $10^6/mm^3$	30	14.2±3.0	109	13.7±1.7
Glucose, mg/dl	22	165 ±77	95	117 ±56

[a]Comprised of values from 'normal' group animals only.

TABLE 5. Clinicochemical parameters of normal Dorcas gazelles showing significant ($p < 0.01$) age-specific variations.

	Neonates		Juveniles		Adults	
Parameter	n	Mean±S.D.	n	Mean±S.D.	n	Mean±S.D.
Hemoglobin, [a] g/dl	58	15.6±2.5	74	16.3±2.1	138	16.6±1.7
MCH, [a,b] $\mu\mu$g	56	11.2±1.4	73	12.4±1.8	135	12.1±1.6
TP, [a,b,e] g/dl	58	5.0±0.7	81	5.6±0.6	149	5.9±0.6
Lymphocytes, [a,b,f] $10^3/mm^3$	51	1.6±0.7	73	2.7±1.0	139	2.0±1.3
Eosinophils, [a,b,e] $10^3/mm^3$	51	0.0±0.0	73	0.1±0.2	139	0.1±0.1
Calcium, [f] mg/dl	6	11.0±1.7	52	9.8±0.9	117	9.2±0.9
Phosphorus, [c,f] mg/dl	6	8.4±1.5	50	8.0±2.7	117	6.5±2.0
Cholesterol, [f] mg/dl	5	91±41	50	70±28	116	54±14
Total Bilirubin, [c,d] mg/dl	5	0.4±0.2	50	0.2±0.1	116	0.2±0.1
Alkaline Phosphatase, [c,f] IU/L	3	1400±390	52	650±1050	117	150±95
LDH, [f] IU/L	5	920±375	52	1025±925	115	635±180

[a]Neonate group significantly lower than adult group.
[b]Neonate group significantly lower than juvenile group.
[c]Neonate group significantly higher than adult group.
[d]Neonate group significantly higher than juvenile group.
[e]Juvenile group significantly lower than adult group.
[f]Juvenile group significantly higher than adult group.

each of the studies. Normal species variation may also account for many of the between-study differences noted.

The venous blood gas and acid-base data of the present study represent the first such data published for Dorcas gazelles. The decreased pH, slightly decreased pCO_2, and the decreased HCO_3 indicate an acid-base status of partially compensated metabolic acidosis. These samples were collected from hand-caught and restrained animals which were generally very excited as evidenced by increased respiration and heart rates. Metabolic acidosis following increased exercise and capture stress has been reported in springbok.[5]

An analysis of the variance within and between animals indicated a high degree of variance within individual animals from bleeding to bleeding. For many parameters, this within animal variance was much greater than the variances seen for values from animal to animal. A number of factors may be responsible for the high degree of within animal variations including differences, at the times of bleeding, in: diet, season of the year, age, reproductive status, and handling stress.

Some of the hematologic and serum chemistry values reported in this study were also probably altered by the excitement and physical exertion of the Dorcas gazelles during capture and bleeding.

The effects of handling and capture stress on clinicochemical and physiological values have been studied in white-tailed deer,[9] bighorn sheep,[4] pronghorn antelopes,[1,8] and springbok.[5] Those effects most usually observed include increased heart and respiration rates, increased rectal temperatures, and increased serum values for glucose, cholesterol, and the serum enzymes. The wide variations in the values obtained for these parameters in the present study may be attributable to different degrees of stress felt by the individual gazelles during handling.

TABLE 6. Clinicochemical parameters of Dorcas gazelles showing significant ($p < 0.01$) health status-specific variation.

	Acute Trauma		Abscess		Post-surgical		Non-specific		Normal	
Parameter	n	Mean±S.D.	n	Mean±S.D.	n	Mean±S.D.	n	Mean±S.D.	n	Mean±S.D.
Hematocrit, %	21	38.4±4.7*	16	35.3±8.2*	11	40.1±4.8*	15	34.2±11.6*	295	46.7±5.0
Hemoglobin, g/dl	20	13.6±1.8*	15	13.3±2.8*	12	14.2±1.6*	15	11.9±3.9*	270	16.3±2.0
RBC, $10^6/mm^3$	17	10.7±1.7*	15	11.6±3.0*	12	10.5±1.6*	15	10.5±2.9*	277	13.8±2.2
MCH, μμg	17	13.1±2.2	14	11.6±1.8	12	13.5±1.3*	15	11.9±1.6	264	12.0±1.6
WBC, $10^3/mm^3$	22	8.8±4.5	15	8.8±4.8	12	9.1±4.2	15	10.8±3.3*	293	6.2±2.6
Neutrophils, %	15	67.9±12.1	16	67.7±19.0	10	75.2±20.3	14	74.9±13.2*	263	59.2±18.9
Lymphocytes, %	15	29.1±11.3	16	29.5±18.4	10	20.8±17.4*	14	22.5±13.0*	263	36.6±18.6
Monocytes, %	15	0.2±0.4*	16	1.2±2.8	10	0.5±0.7	14	1.8±2.2	263	0.8±1.3
Eosinophils, %	15	1.5±4.8	16	0.4±0.9*	10	3.0±6.2	14	0.2±0.8*	263	2.6±4.7
Basophils, %	15	0.3±0.6	16	0.2±0.8	10	0.2±0.4	14	0.0±0.0*	263	0.3±0.7
Calcium, mg/dl	10	8.7±1.1	12	8.3±1.3*	7	8.6±0.9	7	8.9±1.0	175	9.5±1.0
Glucose, mg/dl	11	92±26*	12	133±58	7	136±68	8	114±105	178	126±61
Cholesterol, mg/dl	10	47±13*	12	59±30	7	59±17	6	72±63	173	60±22
Alkaline Phosphatase, IU/l	10	365±315	12	214±207	7	154±85*	7	212±91	172	327±640

*Values significantly different from normal values.

TABLE 7. Comparison of selected values (means) for Dorcas and other gazelles.[a]

Parameter	Dorcas gazelle[b]	Grant's gazelle[c]	Grant's gazelle[d]	Thomson's gazelle[d]
Hematocrit, %	46.7	41	40.9	44.9
Hemoglobin, g/dl	16.3	16	15.7	16.7
RBC, $10^6/mm^3$	13.8	12.7	9.6	10.2
MCV, μ^3	34.5	32.6	—	—
MCHC, %	35.0	37.9	—	—
TP, g/dl	5.7	6.1	—	—
WBC, $10^3/mm^3$	6.2	4.1	2.6	3.0
Calcium, mg/dl	9.5	9.5	11.4	11.0
Phosphorus, mg/dl	7.0	6.1	5.0	4.8
Glucose, mg/dl	126.0	183.0	—	—
BUN, mg/dl	22.6	21.0	—	—
Uric Acid, mg/dl	.28	.48	—	—
Cholesterol, mg/dl	60.2	81.0	—	—
Total Bilirubin, mg/dl	.22	.32	—	—
Alkaline Phosphatase, IU/l	327	235	—	—
LDH, IU/l	763	184	—	—
SGOT, IU/l	203	79	—	—
Sodium, mEq/l	151.3	151.0	—	—
Potassium, mEq/l	5.2	4.4	—	—
Chloride, mEq/l	112.7	108.0	—	—

[a]See original publications for further details.
[b]Present study.
[c]Seal and Schobert, 1976.
[d]Drevemo *et al.,* 1974.

Significant sex-specific variations were seen in certain of the clinicochemical measures of the present study's Dorcas gazelles. The importance of these differences is not clear at the present time. A number of age-related variations were also found. The biological significance of some of these differences may be explained. The decreasing concentrations of alkaline phosphatase observed with increasing age is reflective of the younger animal's active bone metabolism and growth. Likewise, the increased calcium and phosphorus concentrations of the younger animals are indicative of the same bone growth activity. The lower TP values seen in the neonates and juveniles probably reflect the relative deficiency of immonoglobulins in young animals as compared to adults. The importance of the remaining sex-specific and age-specific differences is speculative and cannot be adequately explained until more data of this type is available for non-domestic species.

Acknowledgement

The authors thank Charles D. Roberts, Ph.D., for assistance with data analysis.

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Received for Publication 31 July 1980