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Source: Journal of Wildlife Diseases, 27(3) : 417-420

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-27.3.417

Journal of Wildlife Diseases, 27(3), 1991, pp. 417–420

HEMATOLOGICAL AND BLOOD CHEMISTRY PROFILES OF AMERICAN BISON GRAZING ON KONZA PRAIRIE OF KANSAS

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ABSTRACT: Normal hematological and blood chemistry parameters were measured in 45 American bison (*Bison bison*) that were divided into three age groups for comparison. There was a statistically significant ($P < 0.05$) increase with advancing age in mean corpuscular volume, mean corpuscular hemoglobin, absolute neutrophil and eosinophil counts, total protein, globulin, creatinine, and blood urea nitrogen. There was a statistically significant ($P < 0.05$) decrease with advancing age in levels of sorbital dehydrogenase, alkaline phosphatase, glucose, sodium, calcium and phosphorus.

Key words: Hematology, blood chemistry, American bison, *Bison bison*, age groups.

INTRODUCTION

American bison (*Bison bison*) are becoming more popular in the United States both for production of lean red meat and for research purposes (Dineen, 1986). Because of increased popularity, there is increased demand for physical examination and interpretation of the hematological and blood chemistry values of bison. Some normal hematologic and blood chemistry values for wild bison on the range (Marler, 1975; Mehrer, 1976; Sikarskie et al., 1990), and under experimental conditions (Keith and Ellis, 1978; Hawley and Peden, 1982) have been reported. The purpose of the our study was to determine the differences in hematologic and blood chemistry values in three different age groups of bison.

STUDY AREA AND METHODS

The study herd consisted of 45 American bison which was divided into three age groups: Two males and six females that were ≤6-mo-old; six males and seven females with an age range of 7- to 23-mo-old; and six males and eighteen females that were ≥24-mo-old. Bison were maintained on 469-ha of native tallgrass prairie, part of the 3,487 ha Konza Prairie Research Natural Area, located in the northern Flint Hills (96°32′W to 96°37′W, 39°03′N to 39°07′N) in Riley and Geary Counties, Kansas (USA). Dominant grasses are big bluestem (*Andropogon gerardi*), Indian grass (*Sorghastrum nutans*), little bluestem (*A. scoparius*) and switch grass (*Panicum virgatum*) (Hulbert, 1985).

The Konza Prairie bison herd was established in 1987 with 22 animals from Fort Riley, Kansas. Seven additional animals were subsequently obtained from private owners at Longford, Kansas. The remainder were born on the site. Bison graze freely on good quality range, with minimum management and continuous access to pond water.

In the present study, all bison were attracted to a corral on 30 October 1989, by a 12 hr period of supplemental feeding with a 14% protein pellet. They were kept in the corral for 24 hr prior to blood sampling with brome hay and water continuously available during this period. All bison were randomly handled over a 5 hr period in a circular corral leading to a restraint chute. We collected blood by venipuncture of the external jugular and coccygeal veins into EDTA and serum tubes. The erythrocyte counts, hemoglobin content, packed cell volume, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, and total white blood cell counts were determined and calculated utilizing a Coulter Counter (Coulter S Plus IV, Coulter Electronics Inc, Hialeah, Florida 33010, USA). Blood films for absolute differential white blood cell counts were prepared, and 100 cells were counted. Fibrinogen was determined by refractometry (AO Veterinary Refractometer, AO Scientific Instruments, Buffalo, New York 14215, USA). Serum was assayed for total protein, albumin, globulin, alkaline phosphatase, creatinine, urea nitrogen, glucose, sodium, potassium, chloride, calcium, and inorganic phosphorus with a multichannel biochemical analyzer (Discrete Analyzer with Continuous Optical Scanning (DACOS) Coulter Corporate Communications, Hialeah, Florida 33012, USA). Sorbital dehydrogenase levels were

TABLE 1. Hematological values of three age groups of bison.

	Group 1[a] (n = 7)	Group 2[b] (n = 10)	Group 3[c] (n = 23)
Red blood cells ($\times 10^6$)	11.94^{d} ± 0.25	9.64^{d} ± 0.21	9.12^{d} ± 0.14
Hemoglobin (g/dl)	17.94^{d} ± 0.38	17.92^{d} ± 0.31	18.36^{d} ± 0.21
Packed cell volume (%)	50.77^{d} ± 1.11	50.48^{d} ± 0.92	51.75^{d} ± 0.61
Mean corpuscular volume (fl)	42.97^{d} ± 1.07	52.37^{e} ± 0.89	56.86^{f} ± 0.59
Mean corpuscular hemoglobin (pg)	15.04^{d} ± 0.44	18.60^{e} ± 0.37	20.35^{f} ± 0.24
Mean corpuscular hemoglobin concentration (g/dl)	35.35^{d} ± 0.21	35.50^{d} ± 0.18	35.49^{d} ± 0.11
White blood cells ($\times 10^3$)	8.45^{d} ± 0.94	9.38^{d} ± 0.79	10.59^{d} ± 0.52
Absolute neutrophils ($\times 10^3$)	2.45^{d} ± 0.59	3.94^{d} ± 0.49	5.19^{e} ± 0.32
Absolute lymphocytes ($\times 10^3$)	5.55^{d} ± 0.50	4.63^{d} ± 0.49	4.65^{d} ± 0.32
Absolute monocytes ($\times 10^3$)	0.34^{d} ± 0.09	0.41^{d} ± 0.08	0.32^{d} ± 0.05
Absolute eosinophils ($\times 10^3$)	0.08^{d} ± 0.12	0.32^{de} ± 0.10	0.39^{e} ± 0.06
Absolute basophils ($\times 10^3$)	0.00^{d} ± 0.02	0.04^{d} ± 0.01	0.03^{d} ± 0.01

[a] Group 1 are bison 6 months of age or younger.
[b] Group 2 are bison 7–23 months of age.
[c] Group 3 are bison 24 months of age or older.
Data are expressed as mean ± SE.
[d,e,f] Means in a row with the same superscript are not significantly different ($P < 0.05$).

determined with a bichromatic analyzer (Abbott VP Bichromatic Analyzer, Abbott Laboratories, Diagnostics Division, Dallas, Texas 75247, USA).

The three age groups of bison were compared by one-way analysis of variance. Multiple comparisons were performed using Fisher's least significant differences following a significant ($P < 0.05$) age effect. This test was used because of unequal sample size.

RESULTS

A statistically significant ($P < 0.05$) difference occurred between age groups in the following: mean corpuscular volume, mean corpuscular hemoglobin, and absolute neutrophil and eosinophil counts (Table 1). All values significantly increased with advancing age.

A significant ($P < 0.05$) difference occurred between age groups for the following serum values: total protein, globulin, sorbital dehydrogenase, alkaline phosphatase, creatinine, urea nitrogen, glucose, sodium, chloride, calcium, and phosphorus (Table 2). The total protein, globulin, creatinine, and urea nitrogen ($P < 0.05$) increased with advancing age, whereas the sorbital dehydrogenase, alkaline phosphatase, glucose, sodium, calcium, and phosphorus decreased ($P < 0.05$) with advancing age.

There was no significant difference ($P > 0.05$) based on sex or sex by age interaction, except for the total protein, fibrinogen, and glucose (Table 3). Females ≤6-mo-old were significantly ($P < 0.05$) lower in total protein than all age groups by sex combinations except for males of the same age group, while females ≥24-mo-old were significantly higher ($P < 0.05$) than all other sex by age group combinations. Fibrinogen in males ≥24-mo-old was significantly ($P < 0.05$) higher than all other age groups by sex combinations. There was a significant difference ($P < 0.05$) in blood glucose between males and females, the mean for the females was 161.6 mg/dl and the males was 123.8 mg/dl.

DISCUSSION

The erythrocytic parameters (red blood cells, hemoglobin, packed cell volume, mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration) are within previously reported ranges of reference values (Mehrer, 1976; Hawley and Peden, 1982; Clemens et al., 1987). Both mean corpuscular volume and mean corpuscular hemoglobin significantly increased with advancing age. The red blood cell count,

TABLE 2. Blood chemistry values of three age groups of bison.

	Group 1[a] (n = 7)	Group 2[b] (n = 10)	Group 3[c] (n = 23)
Total protein (g/dl)	7.24[d] ± 0.19	8.13[e] ± 0.15	8.77[f] ± 0.11
Albumin (g/dl)	4.58[d] ± 0.09	4.47[d] ± 0.07	4.59[d] ± 0.05
Globulin (g/dl)	2.65[d] ± 0.17	3.66[e] ± 0.14	4.18[f] ± 0.10
Fibrinogen (mg/dl)	300.00[d] ± 37.21	340.00[d] ± 31.13	360.00[d] ± 20.53
Sorbital dehydrogenase (IU)	12.55[d] ± 0.80	10.96[de] ± 0.70	9.61[e] ± 0.51
Alkaline phosphatase (U/l)	109.00[d] ± 9.11	77.36[e] ± 7.27	38.70[f] ± 5.39
Creatinine (mg/dl)	2.22[d] ± 0.10	2.46[de] ± 0.08	2.51[e] ± 0.06
Urea nitrogen (mg/dl)	17.57[d] ± 0.77	18.63[de] ± 0.62	19.65[e] ± 0.46
Glucose (mg/dl)	176.85[d] ± 16.64	138.27[de] ± 13.27	133.30[e] ± 9.84
Sodium (mmol/l)	154.14[d] ± 1.07	149.54[e] ± 0.85	151.30[e] ± 0.63
Potassium (mmol/l)	5.88[d] ± 0.53	5.62[d] ± 0.42	5.54[d] ± 0.31
Chloride (mmol/l)	103.14[de] ± 0.70	102.81[d] ± 0.56	104.50[e] ± 0.41
Calcium (mg/dl)	11.04[d] ± 0.19	9.83[e] ± 0.15	9.63[e] ± 0.11
Phosphorus (mg/dl)	10.27[d] ± 0.63	7.31[e] ± 0.50	5.83[f] ± 0.37

[a] Group 1 are bison 6 months of age or younger.
[b] Group 2 are bison 7–23 months of age.
[c] Group 3 are bison 24 months of age or older.
Data are expressed as mean ± SE.
[d,e,f] Means in a row with the same superscript are not significantly different ($P < 0.05$).

hemoglobin content, and packed cell volume values of our bison are above the range reported for domestic bovine, ovine, and caprine ruminant species (Coles, 1986).

The neutrophil, monocyte, eosinophil, and basophil counts were within the range of previously reported values (Marler, 1975; Mehrer, 1976; Keith and Ellis, 1978), but the total white blood cell and lymphocyte counts of bison ≥24-mo-old were above the range reported by Mehrer (1976). The white blood cell, neutrophil, lymphocyte, monocyte, and eosinophil counts are comparable to ranges reported for the bovine, ovine, and caprine species (Coles, 1986).

Total protein and globulin significantly ($P < 0.05$) increased with advancing age, but the albumin and fibrinogen levels remained stable among the different age groups of bison. Most of the values are similar to previously reported data (Marler, 1975; Keith, 1978; Hawley and Peden, 1982), however, total protein was higher than the values reported for bison on a low protein, low energy diet (Hawley and Peden, 1982). The increased total protein levels that occur with advancing age are due to increased globulin levels, which probably reflect a maturing immunological system (Kaneko, 1989).

TABLE 3. Blood chemistry values compared between sex and age groups.

Group	Sex	Total protein (g/dl)	Fibrinogen (mg/dl)
Group 1 (n = 6)[a]	Females	7.06[d] ± 0.21	320[d] ±35.48
Group 1 (n = 2)[a]	Males	7.70[de] ± 0.33	250[d] ±56.10
Group 2 (n = 7)[b]	Females	7.98[e] ± 0.21	300[d] ±35.48
Group 2 (n = 6)[b]	Males	8.26[e] ± 0.19	380[d] ±35.48
Group 3 (n = 18)[c]	Females	8.88[f] ± 0.12	317[d] ±19.24
Group 3 (n = 6)[c]	Males	8.32[e] ± 0.23	483[e] ±32.39

[a] Group 1 are bison 6 months of age or younger.
[b] Group 2 are bison 7–23 months of age.
[c] Group 3 are bison 24 months of age or older.
Data are expressed as mean ± SE.
[d,e,f] Means in the same column with the same superscript are not significantly different ($P < 0.05$).

Sorbital dehydrogenase, a liver-specific enzyme, will commonly elevate when acute pathological damage occurs to the liver (Coles, 1986), but this enzyme also decreased with advancing age. Alkaline phosphatase, an enzyme associated with osteoblastic activity and an index of growth, decreased with advancing age in the bison. Higher values of this enzyme have also been observed in juvenile pronghorns (*Antilocapra americana*) (Pedersen and Pedersen, 1975) and elk (*Cervus elaphus*) (Barrett and Chalmers, 1977). Blood creatinine and urea nitrogen are used to assess urinary function, and the values from our bison are comparable to those of a bison group on a high energy-high nitrogen diet (Keith, 1978) and also paralleled the increased total serum protein that occurred with advancing age.

Blood glucose, sodium, calcium, and phosphorus decreased ($P < 0.05$) and chloride ($P < 0.05$) increased with advancing age, whereas the potassium remained similar throughout all age groups. Other studies have suggested that many environmental factors, such as stress, disease, excitement, and circadian and diurnal rhythms, can cause variation in hematological and blood chemistry parameters (Franzmann, 1971; Pedersen and Pedersen, 1975). Some of the age and sex group differences in blood chemistry values are difficult to explain.

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Received for publication 26 March 1990.