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SERUM CHEMISTRY OF THE DIAMOND-BACKED WATER SNAKE (*NERODIA RHOMBIFERA RHOMBIFERA*) IN ARKANSAS

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ABSTRACT: Seventeen serum chemistry analyses were performed on blood collected from captive diamond-backed water snakes. Means, standard deviations, and ranges were calculated for each assay. There was no correlation between the chemistry values and sex or size. The reported values for sodium, potassium, glucose, and total protein fell within the ranges found in the present study, but the values for chloride and blood urea nitrogen were higher, and calcium, bicarbonate, and osmolality were lower. Some snakes had unexpectedly very low serum glucose values which could not be explained by technique or methodology. There was a wide range in enzyme measurements which could be partly due to handling prior to death.

INTRODUCTION

Water snakes are abundant in many areas. These snakes can be obtained relatively easily from the wild and may serve as reptilian models for anatomic (Neudeck, 1969; Raviola and Raviola, 1969), physiologic (Dantzer, 1968; Turner and Tipton, 1972), and environmental contamination studies (Stafford et al., 1976; Heinze et al., 1980). They also could be used in experimental studies of infectious and degenerative disease processes. Knowledge of serum biochemical values would be helpful in disease recognition and in monitoring the condition of the experimental animals used in such studies. However, there is a dearth of information available concerning normal blood chemistry values of snakes in general and specifically in water snakes (Dessauer, 1970). The diamond-backed water snake is commonly found in central Arkansas and other areas of the southern United States and could serve well as a convenient experimental animal. A group of these snakes was captured and examined during the summer of 1982 to better define statistically normal values for a variety of common serum chemistry assays. This report presents the data obtained in that study.

MATERIALS AND METHODS

Snakes were captured in Lonoke County, Arkansas during the month of June 1982, and were maintained at 23–26 C in a fasting condition for 2 to 5 days. The temperature in the laboratory on the days of killing was 23–24 C. The snakes were decapitated and bled into plastic weighing boats. Blood was transferred to commerically obtained blood clot tubes and the serum separated for testing by centrifugation. Sodium, potassium, total carbon dioxide, chloride, blood urea nitrogen, creatinine, glucose, calcium, and the anion gap values were determined within 4 hr of collection on a Beckman Astra-8 (Beckman Instruments, Inc., Brea, California 92621, USA) using Standard Beckman Astra methodologies and reagents. Aliquots of the serum were frozen within 3 hr postcollection and maintained at −80 C. The remainder of the assays were run within 3 wk on the previously frozen serum samples. Osmolalities were performed on an Osmette-A (Precision System, Inc., Sudbury, Massachusetts 01776, USA). Phosphorus and magnesium were tested on an Abbott ABA-100 (Abbott Laboratories, Diagnostic Division, North Chicago, Illinois 66064, USA) using Pierce reagent kits (Pierce Chemical Company, Rockford, Illinois 61105, USA). Total bilirubin was assayed on the ABA-100 using Abbott "A-Gent" reagents (Abbott Laboratories, Diagnostic Division, North Chicago, Illinois 66064, USA). Total protein was performed by a standard biuret technique on the ABA-100. Lactate dehydrogenase, creatine kinase, and alkaline phosphatase were assayed on a Roto

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TABLE 1. Serum chemistry values for the diamond-backed water snake in Arkansas.

	Number snakes tested	Means	Standard deviation	Low values	High values
Sodium (mmol/liter)	28	165.6	4.6	154.0	175.0
Potassium (mmol/liter)	28	4.6	0.9	2.8	6.4
Chloride (mmol/liter)	28	127.0	3.2	117.0	131.0
Carbon dioxide (mmol/liter)	28	19.7	3.0	11.4	26.0
Glucose (mg/dl)	28	33.0	21.0	4.0	97.0
Blood urea nitrogen (mg/dl)	28	1.1	0.79	0.0	3.0
Creatinine (mg/dl)	28	0.65	0.33	0.30	1.80
Anion gap (mmol/liter)	26	18.8	4.1	13.0	26.0
Osmolality (mOsm/kg H_2O)	26	317.8	9.4	297.0	336.0
Calcium (mmol/liter)	28	6.9	0.5	5.6	8.0
Phosphorus (mmol/liter)	28	1.4	0.45	0.7	2.5
Magnesium (mmol/liter)	28	1.2	0.14	0.9	1.5
Total bilirubin (mg/dl)	27	0.57	0.17	0.30	1.00
Total protein (g/dl)	28	5.8	0.9	4.3	7.6
Lactate dehydrogenase (IU/liter)	26	190.6	117.5	69.0	538.0
Creatine kinase (IU/liter)	27	262.4	122.7	92.0	572.0
Alkaline phosphatase (IU/liter)	27	68.7	26.3	27.0	157.0

Chem IIa 36 (American Instrument Company, Silver Springs, Maryland 20910, USA) using SKI Chem reagents (Smith Kline Instruments, Inc., Sunnyvale, California 94086, USA).

Sixteen female and 12 male snakes were included in the study. They ranged in length (snout to vent) from 69 cm to 109 cm ($\bar{x}$ = 82.6 cm; SD 9.0 cm), Student's t-test was used to test for significant differences in values between sexes and length of snakes. Snakes of 69 cm to 80 cm were compared to those with a length of 81–110 cm.

RESULTS AND DISCUSSION

The number of snakes tested, assay means, standard deviations and low and high values are summarized in Table 1. There were no statistical differences in values for male and female snakes, nor could a significant correlation be found between the values and length of snakes ($P \geq 0.20$). None of the snakes had demonstrable blood parasites.

The only blood chemistry data on the diamond-backed water snake found in a literature search was that published by Dessauer (1970). Neither the exact number of snakes examined nor the test methodologies were described in the text. Dessauer performed nine of the same assays as this study. His sodium, potassium, glucose, and total protein values fell within the ranges found in the present study while his values for choride and blood urea nitrogen (BUN) were higher and calcium values lower. A specific urease technique was used in the present study and, therefore, a lower BUN value would be expected. Although Dessauer measured bicarbonate rather than total carbon dioxide, the unit values can be compared. His results are lower than any found in the present study. Dessauer's value for osmotic pressure is given in mOsm/liter rather than mOsm/kg H_2O, therefore, only a rough comparison can be made, but it would appear that his value is obviously lower than those found in this study.

Data are available on other species of snakes for a number of blood chemistry tests, including the nine mentioned above as well as magnesium, phosphorus, creatinine, and bilirubin. The results are generally similar to the values obtained in the present study (Carmichael and Petcher, 1945; Hutton, 1958; Izard et al., 1961; Dessauer, 1970; Chiodini and Sundberg, 1982).

Lactate dehydrogenase and alkaline phosphatase values have been determined by Martin and Bagby (1973) on the western diamondback rattlesnake, *Crotalus atrox* and by Chiodini and Sundberg (1982) on the common boa constrictor, *Constrictor constrictor*, but due to differing units of measurement and assay conditions, no valid numerical comparisons can be made. No comparative data on snakes could be found for creatine kinase or anion gap.

Striking elevations of plasma calcium, phosphorus, and protein occur during the period of estrus in snakes (Dessauer, 1970). However, the breeding period of the diamond-backed water snake occurs in the early spring in central Arkansas and was completed prior to the time of this study. No sex differences in serum calcium, phosphorus, or protein were anticipated on this basis and none were seen.

There was a wide range of values with each of the enzymes studied. It is possible that some of the values may have been elevated by tissue injury. Predecapitation handling may have caused release of the enzyme from tissues into the blood. The range of lactate dehydrogenase values was about 40% greater and the alkaline phosphatase values about 100% greater than those found in the boa constrictor (Chiodini and Sundberg, 1982) and in the diamondback rattlesnake (Martin and Bagby, 1973). The boa constrictors were bled after halothane-nitrous oxide anesthesia and the diamondback rattlesnake after ether anesthesia. The anesthesia probably allowed blood samples to be taken with less handling of the snakes. What effect the anesthesia may have had on the serum enzyme levels is not known.

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