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Serum Biochemistry of Free-Ranging European Bison

Elżbieta WOŁK [1] & Elżbieta JÓZEFCZAK

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The paper presents the values of biochemical parameters of serum for 86 European bison from the Białowieża Primeval Forest. The samples were taken during the winter period. Some biochemical values were found to be age-dependent. The level of potassium, inorganic phosphorus and cholesterol as well as sodium, glucose and carbon dioxide is considerably higher in calves' serum in comparison to older animals. However, the level of creatinine rises with the age of bison and is significantly higher in full-grown animals than in young ones and calves. The activity of alkaline phosphatase is considerably higher in calves while compared to adult animals. The values of biochemical indices of serum of European bison, American bison and domestic cattle have been compared. The general level as well as the tendencies to changes connected with age are similar for these species. Bigger differences apper only in BUN and CK values.

[Mammals Res. Inst., Polish Acad. Sci., 17-230 Białowieża, Poland (EW) and Inst. Postgrad. Educ., Milit. Medic. Acad., 00—909 Warszawa Poland (EJ)].

1. INTRODUCTION

There are few data concerning biochemical values of serum of animals of *Bison* genus. Marler (1975), Keith *et al.* (1976) and Havley and Peden (1982) examined some of the serum parameters of American bison, *Bison bison* (Linnaeus, 1758). The two last works present responses of blood components to nutritional and some other factors. There are no appropriate data about the serum of European bison *Bison bonasus* (Linnaeus, 1758). In blood researches of this species done up till now, the hematological parameters (Wołk, 1983) and serum proteins (Wołk & Józefczak, 1984) were established.

This paper reports the results of studies of 13 serum biochemical values and the activity of 8 serum enzymes in free-ranging bison. The findings have been used to establish reference values for adult bison and to elevate the variation in serum chemistry values associated with sex, age and health status. The obtained data were compared to the parameters of serum of European bison living in a pen, as well as American bison and domestic cattle.

[1] Present address: Teacher Training Institute, Sienkiewicza 38, 87-100 Toruń, Poland.

2. MATERIAL AND METHODS

The blood samples come from 86 bison (76 free-ranging and 10 from a closed breeding) from the Białowieża Primeval Forest (NE Poland). Those animals were shot as a result of elimination of late-born calves, supernumerary and agressive ones and those of bad physical condition. Those were the same bison on which in 1980—1983 hematological research had been carried out (Wołk, 1983) and the research of serum proteins (Wołk & Józefczak, 1984) and also the bison shot in 1984. All the material taken into consideration in calculations comes from a winter period (November-March), which allows for omitting seasonal variation. Blood samples were taken from a cut jugular vein, immediately after a bison had been shot. The blood which was cooled straight away, was centrifuged within a few hours and the obtained serum was stored at −15°C. Serum levels of glucose, cholesterol, urea nitrogen (BUN), creatinine, uric acid, total bilirubin, triglycerides, alkaline phosphatase (ALP), acid phosphatase (ACP), inorganic phosphorus (In. Phosphorus), calcium, amylase, γ-glutamyl transpeptidase (γ-GTP) were determined by the use of Technicon RA-1000 and SMA 12 autoanalysers, using different sets of reagents. The activity of aspartate aminotransferase (SGPT), creatinine kinase (CK), α-hydroxybutyrate dehydrogenase (α-HBDH), lactate dehydrogenase (LDH) were determined by the use of a Baker ENCORE autoanalyser, using the reagents of a firm named Smith-Kline. Methods of determination of the activity of the serum enzymes listed above are based on the Warburg's optical test and adjusted to automated estimation. Sodium, potassium, chloride and bicarbonate values were obtained with the use of a Technicon C-800 autoanalyser and a determination method was based on potentiometric estimations with the use of ionoselective electrodes.

Student *t*-test was used for the statistical evaluation of the differences between means of biochemical values of the serum of adult males and females. The values of indices in three age groups were compared using analysis of variance and Duncan's new multiple range test.

The examined bison were sectioned by the veterinary service of Białowieża National Park and the general data about the state of animals' health come from this source.

3. RESULTS

The values of biochemical indices of serum of adult male and female bison do not differ, except for the level of triglycerides which, with a big variation, is higher in cows ($p<0.05$, Table 1).

A lot of biochemical indices of serum change with the age of bison (Table 2). Levels of chloride, calcium, triglycerides, total bilirubin and BUN do not change with age. Quite noticeable is a distinctly higher level of potassium, inorganic phosphorus and cholesterol in calves serum ($p<0.01$) and also slightly higher level of glucose and bicarbonate ($p<0.05$) in comparison to older animals. However, the level of creatinine rises with the bison's age and is higher in adult bison than in animals of 1—4 years of age ($p<0.05$) and in calves ($p<0.01$), (Table 2, Fig. 1).

The activity of enzymes of bison serum ranges within wide limits which masks possible variability connected with the animals' age. Only

the activity of alkaline phosphatase is substantially higher in case of calves than adult animals ($p<0.01$), (Table 2, Fig. 1).

Most of serum biochemical indices of bison from breeding pens have change tendencies connected with age (Table 3) similar to those observed

Table 1

Serum biochemical values of adult males and females of European bison (free-ranging and from enclosures). Average ($\bar{x}$), and standard deviation (SD), or range (r) are given.

Parameter	Males, $N=17$		Females, $N=14$	
	$\bar{x}$	$SD(r)$	$\bar{x}$	$SD(r)$
Sodium, mEq/l	143.53	5.77	146.86	6.85
Potassium, mEq/l	5.26	1.22	5.44	1.13
Chloride, mEq/l	98.35	4.28	102.64	8.22
Calcium, mg/dl	8.24	1.84	8.09	1.50
Bicarbonate, mmol/l	24.46	1.92	24.03	4.75
In. Phosphorus, mg/dl	4.89	1.36	5.54	1.42
Glucose, mg/dl	59.88	10.73	70.50	22.67
Cholesterol, mg/dl	93.29	41.01	107.29	49.48
Triglycerides, mg/dl	22.31	10.30	42.22 [1]	34.42
Total Bilirubin, mg/dl	0.22	0.09	0.23	0.07
BUN, mg/dl	17.71	6.53	20.00	10.75
Creatinine, mg/dl	1.72	0.46	1.83	0.46
Uric Acid, mg/dl	1.54	0.32	1.40	0.41
SGOT, IU/l	81.29	(34—506)	55.07	13.98
SGPT, IU/l	28.24	20.93	19.21	4.52
ALP, IU/l	58.59	15.99	55.64	19.98
LDH, IU/l	605.18	218.82	651.57	244.04
α-HBDH, IU-l	774.35	389.23	704.79	369.87
γ-GTP, IU/l	22.15	9.41	19.21	4.52
CK, IU/l	316.94	(70—3700)	276.36	(24—1090)
Amylase, IU/l	63.12	27.91	77.21	67.69
ACP, IU/l	3.56	(0.5—13.0)	2.01	1.87

[1] $0.02<p<0.05$.

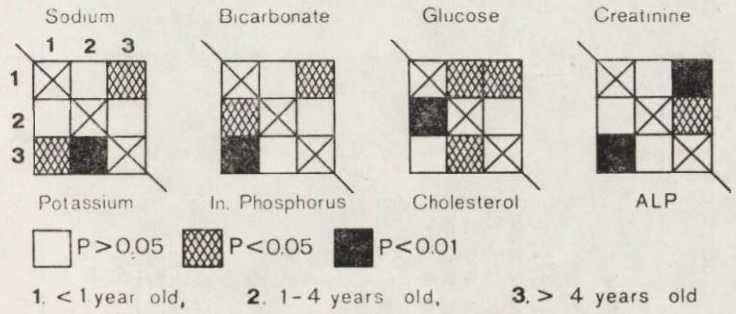

Fig. 1. Significant differences between serum biochemistry of the European bison. Data with no differences were omitted. The analysis of variance and Duncan's new multiple range test were used to determine statistical differences.

Table 2

Serum biochemical values of free-ranging European bison. Average ($\bar{x}$), and standard deviation (SD) or average and range (r) are given.

Parameter	<1 year old, $N=33$		1—4 years old, $N=15$		>4 years old, $N=28$	
	$\bar{x}$	$SD(r)$	$\bar{x}$	$SD(r)$	$\bar{x}$	$SD(r)$
Sodium, mEq/l	141.36	5.06	141.73	5.64	144.93	6.50
Potassium, mEq/l	6.68	1.26	5.21	0.76	5.40	1.23
Chloride, mEq/l	96.51	4.39	97.67	6.03	99.96	6.86
Calcium, mg/dl	8.55	1.06	8.49	0.93	8.15	1.74
Bicarbonate, mmol/l	27.06	2.85	26.77	3.65	24.61	3.47
In. Phosphorus, mg/dl	6.19	0.77	5.31	0.97	5.11	1.44
Glucose, mg/dl	81.00	29.71	65.73	17.88	65.18	18.51
Cholesterol, mg/dl	120.45	45.04	65.33	17.97	100.46	47.71
Trigycerides, mg/dl	30.84	19.51	27.99	14.58	30.66	(8.8—140.0)
Total Bilirubin, mg/dl	0.21	0.07	0.18	0.05	0.23	0.08
BUN, mg/dl	19.52	6.70	15.20	6.38	18.68	9.18
Creatinine, mg/dl	1.24	0.40	1.45	0.34	1.76	0.44
Uric Acid, mg/dl	1.58	0.70	1.41	0.26	1.49	0.38
SGOT, IU/l	66.00	31.12	42.33	10.41	71.68	(34—506)
SGPT, IU/l	21.36	7.65	17.33	6.46	22.79	16.28
ALP, IU/l	81.97	36.75	65.40	15.48	58.89	17.35
LDH, IU/l	624.91	322.00	582.67	141.15	641.79	238.21
α-HBDH, IU/l	760.91	312.28	687.47	279.65	786.54	375.39
γ-GTP, IU/l	40.63	(11—262)	24.60	9.37	23.20	10.35
CK, IU/l	455.30	(48—3000)	435.20	(70—1320)	425.68	(24—3700)
Amylase, IU/l	69.70	31.98	61.60	37.19	72.85	51.54
ACP, IU/l	2.71	(0.5—14.0)	2.55	(1—12)	3.04	(0.5—13.0)

Table 3

Serum biochemical values of European bison in enclosures in Białowieża. Average ($\bar{x}$), and standard deviation (*SD*) or average and range (*r*) are given.

Parameter	<1 year old, *N*=1 female	1—4 years old, *N*=6		>4 years old, *N*=3	
	$\bar{x}$	$\bar{x}$	*SD(r)*	$\bar{x}$	*SD*
Sodium, mEq/l	151.0	140.50	7.14	146.00	0.82
Potassium, mEq/l	6.8	7.45	4.26	4.83	0.38
Chloride, mEq/l	100.0	94.50	9.99	103.33	5.13
Calcium, mg/dl	9.9	7.23	1.92	8.40	1.39
Bicarbonate, mmol/l	34.5	23.50	8.00	21.50	1.50
In. Phosphorus, mg/dl	7.0	4.82	1.05	5.87	1.26
Glucose, mg/dl	125.0	70.17	21.10	60.00	13.23
Cholesterol, mg/dl	155.0	128.33	62.76	91.67	14.43
Triglycerides, mg/dl	65.0	41.22	(8.8—143.0)	37.33	20.50
Total Bilirubin, mg/dl	0.2	0.33	0.18	0.23	0.06
BUN, mg/dl	14.0	25.00	8.14	19.33	3.51
Creatinine, mg/dl	1.5	1.37	0.35	1.90	0.79
Uric Acid, mg/dl	1.4	2.15	0.64	1.40	0.26
SGOT, IU/l	40.0	103.00	45.08	48.67	10.69
SGPT, IU/l	15.0	29.83	13.45	17.00	6.00
ALP, IU/l	111.0	75.00	27.99	56.00	13.89
LDH, IU/l	144.0	775.33	487.82	480.00	48.00
α-HBDH, IU/l	288.0	767.67	590.13	336.00	127.00
γ-GTP, IU/l	8.0	32.35	15.59	12.00	8.19
CK, IU/l	990.0	149.00	65.77	300.00	158.75
Amylase, IU/l	114.0	57.67	36.39	38.00	24.88
ACP, IU/l	1.0	8.83	3.37	1.17	0.76

in free-ranging animals. However, small age groups in connection with big variability of these indices make statistical analysis impossible.

4. DISCUSSION

Baseline "normal" serum biochemical values of European and American bison are similar both in their utter values and tendencies of age-dependent changes (Table 4). Some differences are undoubtedly connected with a different time of the year of collecting samples from American bison in comparison to European one (October: Marler, 1975; March: Hawley & Peden, 1982; *vs.* November-March: this paper), and therefore also with different nutritive conditions. The activity of SGOT of European and American bison differs rather considerably, but this parameter is not too stable. It seems, that blood collecting from immobilized American bison might have caused animals' stress, and consequently elevated SGOT (LeResche *et al.*, 1974).

Strikingly similar are serum biochemical values of Hereford cattle grazing pastures (Gartner *et al.*, 1966) or on experimental low protein low energy ration (Hawley & Peden, 1982) and those in European bison (Table 4). Greater difference appear only in BUN and CK values. A very low CK value in case of cattle is, undoubtedly, related to its small mobility while compared to bison.

Table 4

Comparison of serum biochemical values for domestic cattle (American bison and

Parameter	Cattle				American bison [b]			
	Calves		Adults		Less than 2 years old		Adults	
	$\bar{x}$	*SD*	$\bar{x}$	*SD*	$\bar{x}$	*SD*	$\bar{x}$	*SD*
Sodium, mEq/l	139.5	4.5	140.4	4.9 [a]				
Potassium, mEq/l	4.9	0.3	4.3	0.3 [a]				
Chloride, mEq/l	106.6	1.9	106.8	2.7 [a]				
Calcium, mg/dl	11.7	0.7	11.2	0.3 [a]	11.0	0.8	10.6	0.6
In. Phosphorus, mg/dl	6.1	0.6	4.9	0.5 [a]	3.5	0.8	2.8	0.8
Glucose, mg/dl	67.7	5.2 [c]						
Cholesterol, mg/l	129.1	25.7 [c]			132.0	54.0	97.0	11.0
Total Bilirubin, mg/dl					0.4	0.2	0.3	0.1
BUN, mg/dl	9.8	1.6 [c]						
Creatinine, mg/l	9.8				3.1	0.4	3.0	0.2
SGOT, IU/l	74.1	10.0 [c]			128.0	31.0	99.0	18.0
SGPT, IU/l								
ALP, IU/l	105.2	24.6 [c]			73	28	48	10
LDH, IU/l								
CK, IU/l	11.4	3.5 [c]						
N		6		6		12		25

[a] Gartner *et al.*, 1966, [b] Marler, 1975, [c] Hawley & Peden, 1982.

Baseline serum biochemical values of bison from stockbreeding pens in Białowieża are, on account of small size of groups, difficult to be compared to data obtained from free-ranging animals. Distinct differences in the activity of enzymes are visible, though big unstability of these parameters was already mentioned above.

Dependence between the level of triglycerides and sex of studied individuals, which occured in bison, is observed also in people.

Importance of the age-specific differences in serum biochemistry values is speculative since there are only few data of this type for wild species. The level of cholesterol higher in calves than in older bison is, undoubtedly, related to the difference in animals' diet: a milk diet of suckling calves and purely vegetarian diet in adult bison. Similarly, Bush *et al.* (1981) proved age-dependent fall of cholesterol level in Dorcas' gazelle, *Gazella dorcas* (Linnaeus, 1758). Calves which are not yet ruminating characteristically have a higher blood glucose content, since the monosaccharides of the food are degradated to lower fatty acids in forestomach in the adult ruminants (Schmidt, 1979). Significantly higher ALP activity in calves than in adult animals is related to the intensive growth of young individuals, due to increased osteoblast activity. Likewise the increased inorganic phosphorus content of the young-

European bison. Average ($\bar{x}$) and standard deviation (*SD*) or average and range (*r*) are given.

American bison [c]				European bison			
Juveniles		Adults		Calves		Adults	
$\bar{x}$	*SD*	$\bar{x}$	*SD*	$\bar{x}$	*SD(r)*	$\bar{x}$	*SD(r)*
				141.4	5.1	144.9	6.5
				6.7	1.3	5.4	1.2
				96.5	4.4	100.0	6.9
				8.6	1.1	8.2	1.7
4.5	0.8	3.7	1.0	6.2	0.8	5.1	1.4
102.0	12.4	98.9	15.0	81.0	29.7	65.2	18.5
78.8	11.7	77.1	17.4	120.5	45.0	100.5	47.7
				0.2	0.1	0.2	0.1
11.2	2.4	11.6	2.8	19.5	6.7	18.7	9.2
				1.2	0.4	1.8	0.4
321.2	149.1	232.1	146.6	66.0	31.1	71.7	(34—506)
				21.4	7.7	22.8	16.3
75.3	18.8	55.5	12.6	82.0	36.8	58.9	17.4
				624.9	322.0	641.8	238.2
476.2	391.6	345.9	328.2	455.3	(48—3000)	425.7	(24—3700)
	6		17		33		28

er animals is indicative of the same bone growth activity. The ALP activity as well as the In. Phosphorus content fall with animals' age was ascertained also by Bush *et al.* (1981) in *Gazella dorcas* and by English and Lepherd (1981) in *Dama dama* (Linnaeus, 1758). The significant fall in serum In. Phosphorus with age of bison also agrees with the findings of Gartner *et al.* (1966) in grazing cattle in Australia and with the findings of Long *et al.* (1965) in sheep. Since creatinine arises endogenously in muscle metabolism its level is higher in individuals with a large muscle mass. It is probably a cause of highly significant differences of creatinine value between a group of adult individuals and younger age groups. Similarly as it was discovered for bison, Long *et al.* (1965) and Gartner *et al.* (1966) reported a significant decline in plasma potassium with age of sheep and cattle. The authors showed no changes of either sodium or chloride with age. Wilson and Pauli (1983), who studied the activity of 4 enzymes and values of 7 serum chemical indices in red deer, *Cervus elaphus* Linnaeus, 1758, found that there were no significant differences in any parameter between age groups.

The relationship between the level of serum biochemical indices and deseases discovered in some of the examined bison is difficult to establish. It is possible that it results, at least partly, from the fact that in many bison, despite the invasion of parasites, there exists some kind of physiological balance between a host organism and a degree of invasion, which was mentioned earlier (Wołk, 1983). Hence, the lack of correlation, for example, between the degree of invasion by *Fasciola hepatica (Trematoda)* and the level of such diagnostic indicators of liver deseases as ALP, bilirubin, SGOT *etc.* One of few examples of a visible connection between health indisposition and a level of serum biochemical indices, may be a strongly increased activity of CK (about 9 times in comparison to average value) and the activity of SGOT increased over twice while compared to average value in case of 4 year old bull strongly battered by the other members of the herd near a feeding rack in December. As is well known, these enzymes are elevated in muscle injury and vigorous exercise (see LeResche *et al.*, 1974; Schmidt, 1979). The SGOT value in another male with an injured leg exceeded the average values 7 times.

It seems, that the obtained hematological and biochemical parameters of serum (Wołk, 1983; Wołk & Józefczak, 1984 and this paper) may serve in monitoring the general health condition and nutritional status of bison. However, the diagnostic values of particular parameters demand further research and experiments.

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Elżbieta WOŁK & Elżbieta JÓZEFCZAK

PARAMETRY BIOCHEMICZNE SUROWICY ŻUBRÓW Z WOLNO ŻYJĄCEGO STADA

Streszczenie

Przedstawiono wartości parametrów biochemicznych surowicy 86 żubrów, *Bison bonasus* (Linnaeus, 1758) z Puszczy Białowieskiej, w tym 76 żubrów z wolno żyjącego stada (Tabela 1 i 2) i 10 z hodowli zamkniętej (Tabela 3). Dane pochodzą od żubrów odstrzelonych zimą w ramach selekcji przeprowadzonej w latach 1980—1984.

Stwierdzono, że wartości niektórych parametrów są zależne od wieku żubrów. Wyraźnie wyższy jest w surowicy cieląt poziom potasu, fosforu nieorganicznego i cholesterolu w porównaniu ze starszymi zwierzętami ($p<0.01$), nieco zaś wyższy jest poziom sodu, glukozy i dwutlenku węgla ($p<0.05$). Natomiast poziom kreatyniny wzrasta z wiekiem żubrów i jest wyższy u zwierząt dorosłych w porównaniu z młodymi 1—4 letnimi ($p<0.05$) i cielętami ($p<0.01$). Aktywność fosfatazy zasadowej jest istotnie wyższa u cieląt, niż u zwierząt dorosłych ($p<0.01$) (Tabela 2, Ryc. 1). Porównano wartości biochemicznych wskaźników surowicy żubra, bizona i bydła domowego. Ogólny ich poziom oraz tendencje zmian związanych z wiekiem są u tych gatunków na ogół podobne, większe różnice występują tylko w wartościach BUN i CK (Tabela 4). Uzyskane w badaniach nad krwią żubra parametry hematologiczne i biochemiczne surowicy mogą służyć w ocenie stanu zdrowotnego i kondycji żubra. Natomiast wartości diagnostyczne poszczególnych parametrów wymagają dalszych badań.