

HAEMATOLOGICAL AND BIOCHEMICAL VALUES IN THE PERIPHERAL BLOOD OF WOLVES /CANIS LUPUS/ KEPT IN THE EAST-BOHEMIAN ZOOLOGICAL GARDEN AT DVŮR KRÁLOVÉ NAD LABEM

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Abstract

Pospíšil J., J. Váhala, P. Špála, F. Kaše: Haematological and Biochemical Values in the Peripheral Blood of Wolves /Canis lupus/ Kept in the East-Bohemian Zoological Garden at Dvůr Králové nad Labem. Acta vet. Brno, 56, 1987: 361-375.

Six adult wolves and 5 young wolves kept in the East-Bohemian Zoological Garden at Dvůr Králové nad Labem were subjected to haematological and biochemical examinations of the peripheral blood. In these two groups of animals determination was made of the mean values of erythrocyte count, haemoglobin content, haematocrit, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration, mean corpuscular volume, leukocyte count and differential leukocyte count. In the blood sera of these animals the mean levels of protein, glucose, creatinine, urea, triglycerides, cholesterol, magnesium, calcium, phosphorus, chlorides, sodium, potassium and alkaline phosphatase and AST and ALT aminotransferase activity were determined. The blood sera of adult wolves were examined in addition for total bilirubin, copper and zinc levels. The peripheral blood of young wolves, compared with adult animals, showed significantly lower erythrocyte count, haematocrit and haemoglobin content and higher leukocyte count. Biochemical examination of the blood sera revealed significantly lower creatinine level, higher cholesterol and phosphorus level and higher alkaline phosphatase activity in young than in adult wolves.

Adult, young, difference, wolf.

Clinically healthy animals kept in the East-Bohemian Zoological Garden at Dvůr Králové nad Labem are examined systematically for haematological and biochemical values in the peripheral blood (Pospíšil et al. 1984a, b, c, d; 1985a, b). The present report gives the results of biochemical and haematological examination of the peripheral blood of wolves /Canis lupus/. Search

for relevant published information revealed blood serum biochemical values of the wolf in the report by Seal et al. (1975) and haematological values in the studies by Dieterich (1970), Hawkey (1975) and Seal et al. (1975).

### Materials and Methods

The animals examined were Euro-asiatic wolves */Canis lupus lupus/* and black wolves */Canis lupus pambasileus/* and crosses between these two species. They were kept together as a pack in an open-air enclosure without a shed throughout the year. They were fed beef or veal three times a week, a mixture consisting of minced meat, oat flakes, carrot, milk-powder, yeast, minerals- and vitamins-containing concentrate and vegetable oil twice a week, living feed (rabbit, coypu, hen) once a week and were left without feed once a week.

The wolves were in good health except for recurrent infections with ascarids */Toxocara canis/* in spite of repeated treatment with antiparasitics.

A total of 6 adult and 5 young clinically healthy wolves were included in the study. Their sex, age the season of examination are shown in Table 1. Before being blood-sampled, adult wolves were immobilized by i. m. administration of IMOBILONE (Reckit and Colman, Pharmaceutical Division, Hull, Ireland) at the dose rate of 0.1 to 0.3 ml/per animal. Young wolves were blood-sampled after capture without being pharmacologically treated. All blood collections were made from the v. saphena. Haematological and biochemical values of the peripheral blood were determined by methods routinely used in clinical practice as described in detail in previous studies (Pospíšil et al. 1984a; 1985b; 1986).

Table 1  
Age of wolves */Canis lupus/* examined and the season of examination

Group	Sex	N	Month/No. animals	Age in years/ /No. animals
Adult wolves	males	3	VII/2, VIII/1	2/2, 4/1,
	females	3	VII/3	2/2, 4/1
Young wolves	males	2	VII/2	Aged 91 days at the time of blood collection
	females	3	VII/3	

N = No. animals

Means  $\bar{X}$  and standard deviations  $/SD/$  were computed from values obtained in individual animals. Comparison of the differences in the mean values between young and adult wolves was made by the t-test. Before applying the t-test, the agreement of the va-

riances was assessed by the F-test at the 5% level of significance and a modification of the t-test was chosen accordingly.

## Results

The haematological values found in the peripheral blood of young wolves are presented in Table 2 and those found in adult wolves are shown in Table 3. The biological values found in the blood serum of young and adult wolves are shown in Table 4 and Table 5, respectively.

## Discussion

Among reports available to us for comparison the most detailed study on haematological and biochemical values in the peripheral blood of wolves was that by Seal et al. (1975) who compared the differences found in 32 young wolves /males having  $19.1 \pm 7.1$  kg and females having  $15.5 \pm 5.9$  kg in body mass/ coming from various areas of Minnesota. Their results are listed in Tables 7 and 8 together with identification of those values that are markedly different from the findings reported in our study. As marked differences were regarded such cases where standard deviations of the corresponding values did not overlap. The haematological values were compared similarly with those reported by Dieterich (1970) and Hawkey (1975) in Tables 9 and 10, respectively. The data reported by Dieterich (1970) were based on 5 repeated examinations of one animal.

The reasons of the differences in some values between our results and the data reported by Dieterich (1970), Hawkey (1975) and Seal et al. (1975) are difficult to analyse because the numbers of animals examined were small in most cases, the only exception being perhaps the study by Seal et al. (1975) who however examined young wildlife wolves. Haematological and biochemical values in the peripheral blood are affected by a number of factors the most important among which are apparently zootechnical conditions, nutritional status, age and physiological status of the animals and the season during which blood collections are made. In all probability these conditions varied from one study to another. The higher proportion of eosinophil granulocyte in our study can be accounted for by the presence of ascarids /*Toxocara canis*/.

Where published information on haematological and biochemical values in the peripheral blood of the wolf is not available, one is likely to resort to the data recorded for the dog /*Canis familiaris*/ although this domesticated animal is kept under considerably different conditions and can be blood-sampled without being affected by pharmaceuticals. Our findings in wolves were compared with the haematological (Schalm et al. 1975; Sova 1979) and biochemical values (Sova 1979; Jagoš and Bouda 1981; Kirk 1980) in the blood serum of the dog /*Canis familiaris*/ in Tables 11 and 12. As marked differences were regarded such cases

Table 2

Haematological values in the peripheral blood of young wolves (*Canis lupus*), crosses between the Eurasian wolf (*Canis lupus lupus*) and the black wolf (*Canis lupus pambasileus*)

Haematological value	Individual values				$\bar{X}$	SD
	male	male	female	female		
Erythrocyte count ( $10^{12}/l$ )	5.64	7.22	5.50	6.48	6.10	0.70
Haematocrit (l/l)	0.32	0.35	0.40	0.33	0.360	0.038
Haemoglobin content (g/l)	131	147	141	139	140.0	5.8
Mean corpuscular haemoglobin (pg)	23.2	20.4	25.6	21.5	22.9	2.0
Mean corpuscular haemoglobin concentration (mmol/l)	23.37	26.06	21.90	26.12	24.26	2.10
Mean corpuscular volume (fl)	56.7	48.5	72.7	50.3	59.0	10.6
Leukocyte count ( $10^9/l$ )	15.8	18.5	18.6	15.0	16.74	1.68
Neutrophil granulocytes (segments)	0.51	0.60	0.39	0.59	0.518	0.084
Neutrophil granulocytes (rods)	0.02	0.01	0.01	0.02	0.014	0.005
Eosinophil granulocytes	0.21	0.09	0.13	0.14	0.148	0.044
Basophil granulocytes	0.00	0.01	0.02	0.00	0.008	0.008
Lymphocytes	0.23	0.23	0.40	0.17	0.260	0.086
Monocytes	0.03	0.06	0.05	0.08	0.052	0.019

$\bar{X}$  = mean value      SD = standard deviation

Table 3  
 Haematological values in the peripheral blood of adult wolves (*Canis lupus*), crosses between the  
Eurasian wolf (*Canis lupus lupus*) and the black wolf (*Canis lupus pambasileus*)

Haematological value	Individual values				$\bar{X}$	SD
	male	female	male	female		
Erythrocyte count ( $10^{12}/l$ )	6.86	7.66	8.08	8.04	7.48	0.54
Haematocrit (l/l)	0.45	0.52	0.53	0.43	0.465	0.048
Haemoglobin content (g/l)	149	170	197	177	172.0	17.3
Mean corpuscular haemoglobin (pg)	21.8	22.2	24.9	22.0	23.06	2.01
Mean corpuscular haemoglobin concentration (nmol/l)	20.66	20.29	23.08	25.56	23.02	2.17
Mean corpuscular volume (fl)	65.6	67.9	65.6	53.5	63.85	4.41
Leukocyte count ( $10^9/l$ )	5.3	4.0	10.7	10.7	7.33	3.15
Neutrophil granulocytes (segments)	0.56	0.64	0.55	0.60	0.578	0.034
Neutrophil granulocytes (rods)	0.08	0.02	0.02	0.01	0.025	0.027
Eosinophil granulocytes	0.14	0.08	0.18	0.11	0.103	0.061
Basophil granulocytes	0.00	0.00	0.00	0.01	0.005	0.005
Lymphocytes	0.17	0.19	0.22	0.24	0.240	0.062
Monocytes	0.05	0.07	0.03	0.07	0.048	0.024

$\bar{X}$  = mean value      SD = standard deviation

Table 4  
 Biochemical values in the blood serum of young wolves (*Canis lupus*), crosses between the Eurasian wolf (*Canis lupus lupus*) and the black wolf (*Canis lupus pambasileus*)

Biochemical value	Individual values				X	SD
	male		female			
	male	female	male	female		
Protein	66.0	57.0	60.0	63.0	62.80	4.43
Glucose	10.2	8.3	10.6	10.2	10.06	1.03
Creatinine	85.0	92.0	80.0	121.0	95.60	16.07
Urea	11.3	11.6	8.7	7.8	10.46	2.12
Triglycerides	3.16	2.58	-	2.95	2.90	0.23
Cholesterol	5.9	6.6	5.8	6.2	5.92	0.55
Alkaline phosphatase	2.14	2.23	1.50	2.20	2.01	0.34
A S T	0.24	0.27	0.28	0.32	0.284	0.032
A L T	0.41	0.41	0.47	0.42	0.424	0.026
Magnesium	0.65	0.58	0.65	0.73	0.658	0.054
Calcium	1.98	1.78	1.80	2.06	1.904	0.118
Phosphorus	2.75	2.77	2.51	2.47	2.608	0.141
Chlorides	126.0	120.0	116.0	123.0	121.2	4.2
Sodium	140.0	121.0	129.0	137.0	131.8	7.3
Potassium	4.85	4.81	5.56	4.96	5.116	0.345

X = mean value

SD = standard deviation

Table 5

Biochemical values in the blood serum of adult wolves (*Canis lupus*), crosses, between the Eurasian wolf (*Canis lupus lupus*) and the black wolf (*Canis lupus pambasileus*)

Biochemical value	Individual values								$\bar{X}$	SD
	male	male	male	female	female	female	female	female		
Total bilirubin	0.49	-	1.8	-	2.91	2.92	2.030	1.153		
Protein	59.0	83.0	70.0	74.0	60.0	65.0	68.50	9.13		
Glucose	14.3	8.3	12.6	10.0	10.7	16.3	12.03	2.95		
Creatinine	185.0	162.0	187.0	181.0	-	133.0	169.6	22.7		
Urea	12.0	4.7	8.0	14.3	9.6	16.4	10.83	4.27		
Triglycerides	1.10	2.19	2.48	1.93	2.93	4.27	2.48	1.06		
Cholesterol	5.18	2.90	5.30	2.90	3.60	3.25	3.855	1.104		
Alkaline phosphatase	0.78	0.46	-	0.22	0.43	0.51	0.480	0.200		
A S T	0.13	0.30	0.16	0.18	0.08	0.79	0.273	0.263		
A L T	0.42	0.64	0.30	0.31	0.29	0.80	0.460	0.212		
Magnesium	0.78	0.64	0.65	0.69	0.65	0.74	0.691	0.057		
Phosphorus	1.59	1.03	1.34	0.72	-	0.97	1.118	0.319		
Chlorides	104.0	128.0	110.0	119.0	-	115.0	115.2	9.0		
Sodium	134.0	156.0	136.0	140.0	133.0	135.0	139.0	8.6		
Potassium	3.63	4.43	3.04	3.60	3.86	4.64	3.866	0.587		
Copper	13.4	-	11.0	12.6	-	-	12.33	1.22		
Zinc	85.4	-	32.6	26.4	-	-	48.13	32.42		
Iron	49.4	-	-	-	-	-	-	-		

$\bar{X}$  = mean value      SD = standard deviation

Table 6

Statistical significance of the differences in the mean peripheral blood values between young and adult wolves

Mean values compared	Statistical significance (%)
Erythrocyte count	0.5
Haematocrit	0.3
Haemoglobin content	0.3
Mean corpuscular haemoglobin	89.8
Mean corpuscular haemoglobin concentration	36.3
Mean corpuscular volume	33.1
Leukocyte count	0.0
Neutrophil granulocytes (segments)	14.1
Neutrophil granulocytes (rods)	39.6
Eosinophil granulocytes	20.3
Lymphocytes	66.4
Monocytes	77.0
Protein level	23.6
Glucose level	19.1
Creatinine level	0.0
Urea level	86.5
Triglyceride level	46.6
Cholesterol level	0.4
Alkaline phosphatase activity	0.0
AST aminotransferase activity	92.9
ALT aminotransferase activity	71.7
Magnesium level	35.3
Calcium level	68.1
Phosphorus level	0.0
Chloride level	26.2
Sodium level	17.4
Potassium level	0.2

Table 7

Haematological values in the peripheral blood of wolves (*Canis lupus*) reported by SEAL et al. (1975)

Haematological value	males (N = 22)		females (N = 10)	
	$\bar{x}$	SD	$\bar{x}$	SD
Erythrocyte count ( $10^{12}/l$ )	5.1 $\triangle$	1.0	5.5 $\triangle$	0.5
Haematocrit (l/l)	0.400 $\circ$	0.040	0.410 $\circ$	0.040
Haemoglobin content (g/l)	127.0 $\delta$	13.0	136.0 $\delta$	9.0
Mean corpuscular haemoglobin concentration (nmol/l)	19.23 $\triangle$	1.24	20.47 $\triangle$	1.24
Mean corpuscular volume (fl) $\circ$	79.0 $\circ$	12.0	77.0 $\circ$	9.0
Leukocyte count ( $10^9/l$ )	14.1 $\circ$	5.9	15.0 $\circ$	3.7

N = No. animals examined

$\bar{x}$  = mean value

SD = standard deviation

1 compared with the values for adult wolves

2 compared with the values for young wolves

The values reported by SEAL et al. (1975) were converted to SI units to make comparison easier.

$\triangle$  the value found in our study is higher than that reported by SEAL et al. (1975),

$\circ$  the value found in our study shows little difference from that reported by SEAL et al. (1975),

$\nabla$  the value found in our study is markedly lower than that reported by SEAL et al. (1975).

where standard deviations of the corresponding values or their ranges did not overlap. As can be seen from Table 12, the blood serum glucose levels of the dog are markedly lower than those found by us in wolves. These findings are also supported by the observations of Seal et al. (1975). To what extent this difference is due to the intervention in endocrine regulation at the time of blood collection or to the existence of a species-specific metabolism is difficult to resolve. Nevertheless, we are inclined to explain the difference as a consequence of non-specific reaction to the load produced by blood collection and the preceding handling of the animals.

The finding of significantly lower values for the red blood picture in young than in adult wolves is in keeping with the observations in dogs by Schalm et al. (1975) who reported that erythrocyte count, haematocrit and haemoglobin content rose steadily in dogs from 2 months of age, reaching adult values in animals aged 1 to 2 years. The difference in leukocyte count is not mentioned by Schalm (1975) but is listed in the roster

Table 8

Biochemical values in the blood serum of wolves (*Canis lupus*)  
reported by SEAL et al. (1975)

Biochemical value	males (N = 22)		females (N = 10)	
	$\bar{X}$	SD	$\bar{X}$	SD
Total bilirubin $\mu\text{mol/l}$	5.13 <sup>v</sup>	3.42	3.42 <sup>v</sup>	1.71
Protein g/l	54.0 <sup>o</sup>	6.0	54.0 <sup>o</sup>	7.0
Glucose mmol/l	8.04 <sup>o</sup>	2.38	9.15 <sup>o</sup>	1.44
Urea mmol/l	3.48 <sup>1</sup>	1.66	2.32 <sup>1</sup>	0.83
Cholesterol mmol/l	5.75 <sup>o</sup>	1.09	5.71 <sup>o</sup>	0.98
Alkaline phosphatase $\mu\text{kat/l}$	0.300 <sup>o</sup>	0.050	0.233 <sup>o</sup>	0.050
A S T $\mu\text{kat/l}$	1.500 <sup>v</sup>	0.750	1.630 <sup>v</sup>	0.555
Calcium mmol/l	2.42 <sup>v</sup>	0.17	2.42 <sup>v</sup>	0.10
Phosphorus mmol/l	2.03 <sup>1</sup>	0.25	2.06 <sup>1</sup>	0.29

N = No. animals examined

$\bar{X}$  = mean value

SD = standard deviation

1 compared with the values found in adult wolves

2 compared with the values found in young wolves

The values reported by SEAL et al. (1975) were converted to SI units using conversion coefficients according to JAGOŠ and BOUDA (1981).

▲ the value found in our study is higher than that reported by SEAL et al. (1975),

○ the value found in our study shows little difference from that of SEAL et al. (1975),

▼ the value found in our study is lower than that reported by SEAL et al. (1975).

by Bentinck-Smith (1980). Comparison of blood serum biochemical values in young and adult wolves showed a significantly lower level of creatinine and higher levels of cholesterol, phosphorus and potassium and higher alkaline phosphatase activity in the younger animals. In the roster by Bentinck-Smith young dogs are listed as having higher phosphorus level and higher alkaline phosphatase activity than adult dogs but no mention is made of differences in creatinine and cholesterol levels.

Our systematic examination of haematological and biochemical values in the peripheral blood of clinically healthy animals kept in the East-Bohemian Zoological Garden is designed to contribute to the understanding of "normal" physiological values of these animals even though we are aware that our findings are only of exploratory value.

Table 9

Haematological values in the peripheral blood of a wolf (*Canis lupus*) reported by DIETERICH (1970)

Haematological value	N	$\bar{X}$ SD	Range
Erythrocyte count ( $10^{12}/l$ )	5	5.31 $\Delta$ +0.09 $\circ$	5.18 - 5.40
Haematocrit (l/l)	5	0.350 $\Delta$ +0.010 $\circ$	0.330- 0.360
Haemoglobin content (g/l)	5	120.0 $\Delta$ +20.0 $\circ$	120.0 -125.0
Mean corpuscular haemoglobin (pg)	5	23.0 $\circ$ +0.6 $\circ$	22.0 - 24.0
Mean corpuscular haemoglobin concentration (nmol)	5	21.71 $\circ$ +3.73 $\circ$	20.47 - 22.33
Mean corpuscular volume (fl)	5	65.0 $\circ$ +2.0 $\circ$	63.0 - 69.0
Leukocyte count ( $10^9/l$ )	5	13.85 $\circ$ +3.66 $\circ$	9.7 - 19.75
Neutrophil granulocytes (segments)	5	0.590 $\circ$ +0.120 $\circ$	0.390- 0.690
Neutrophil granulocytes (rods)	5	0.030 $\circ$ +0.030 $\circ$	0.020- 0.070
Eosinophil granulocytes	5	0.050 $\circ$ +0.020 $\Delta$	0.020- 0.060
Basophil granulocytes	5	0.000 $\circ$ $\circ$	
Lymphocytes	5	0.330 $\circ$ +0.080 $\circ$	0.240- 0.450
Monocytes	5	0.010 $\Delta$ +0.010 $\Delta$	0.010- 0.030

N = No. examinations (1 animal was examined 5 times)

$\bar{X}$  = mean value

SD = standard deviation

The values reported by DIETERICH (1970) were converted to SI units to make comparison easier.

$\Delta$   $\circ$  For explanation of the symbols see Table 8.

Table 10

Haematological values in the peripheral blood of wolves (*Canis lupus*) reported by HAWKEY et al. (1975)

Haematological value	N	$\bar{X}$	Range
Erythrocyte count ( $10^{12}/l$ )	3	5.8	4.9 - 6.3
Haematocrit (l/l)	3	0.420	0.390- 0.480
Haemoglobin content (g/l)	3	150.0	140.0 -155.0
Mean corpuscular haemoglobin (pg)	3	26.0	25.2 - 27.5
Mean corpuscular haemoglobin concentration (nmol/l)	3	21.71	19.23 - 22.55
Mean corpuscular volume (fl) <sub>9</sub>	3	71.5	70.0 - 72.0
Leukocyte count ( $10^9/l$ )	3	7.6	6.8 - 8.1
Neutrophil granulocytes	3	0.750	0.650- 0.850
Eosinophil granulocytes	3	0.030	0.010- 0.060
Basophil granulocytes	3	0.000	0.000- 0.000
Lymphocytes	3	0.180	0.090- 0.260
Monocytes	3	0.040	0.020- 0.050

N = No. animals examined

$\bar{X}$  = mean value

The values reported by HAWKEY (1975) were converted to SI units to make comparison easier.

For explanation of the symbols see Table 8.

Hematologické a biochemické hodnoty periferní krve vlků /*Canis lupus*/ chovaných ve Východočeské zoologické zahradě Dvůr Králové nad Labem

V práci je referováno o výsledcích hematologického a biochemického vyšetření periferní krve 6 dospělých vlků /*Canis lupus*/ a 5 mladých vlků chovaných ve Východočeské zoologické zahradě Dvůr Králové nad Labem. Pro tyto dvě skupiny vlků byly stanoveny průměrné hodnoty počtu červených krvinek, obsahu hemoglobinu, hematokritu, středního množství hemoglobinu červené krvinky, střední koncentrace hemoglobinu červené krvinky, středního objemu červené krvinky, počtu bílých krvinek, zastoupení jednotlivých druhů bílých krvinek. V krevním séru byly stanoveny průměrné hodnoty hladiny bílkovin, glukózy, kreatininu, močoviny, triglyceridů, cholesterolu, hořčíku, vápníku, fosforu, chloridů, sodíku, draslíku, aktivity alkalické fosfatázy, aminotransferázy AST a ALT. U dospělých vlků byla dále stanovena hladina celkového bilirubinu, mědi a zinku. V periferní krvi mladých vlků byl zjištěn statisticky významně nižší počet červených krvinek, hematokritu a obsahu hemoglobinu a vyšší počet bílých krvinek. Z biochemických hodnot

Table 11

Comparison of haematological values in the peripheral blood of wolves (*Canis lupus*) with those reported for the dog (*Canis familiaris*)

Haematological value compared	SCHALM et al. 1975		SOVA 1979	
	a	b	a	b
Erythrocyte count	•	•	•	•
Haematocrit	∇	•	∇	•
Haemoglobin content	•	•	∇	•
Mean corpuscular haemoglobin	•	•	∇	∇
Mean corpuscular haemoglobin concentration	∇	∇	∇	•
Mean corpuscular volume	∇	•	∇	∇
Leukocyte count	•	•	∇	•
Neutrophil granulocytes	∇	∇	•	•
Eosinophil granulocytes	∇	∇	•	•
Basophil granulocytes	•	•	•	•
Lymphocytes	•	•	•	•
Monocytes	•	•	•	•

a = compared with the values obtained in young wolves

b = compared with the values obtained in adult wolves

∇ = the value found in wolves is higher than that reported for the dog,

• = the value found in wolves shows little difference from that reported for the dog,

∇ = the value found in wolves is lower than that reported for the dog.

krevního séra byla u mladých vlků zjištěna statisticky významně nižší hladina kreatininu, vyšší hladina cholesterolu a fosforu a vyšší aktivita alkalické fosfatázy.

Гематологические и биохимические величины периферической крови волков (*Canis lupus*), содержащихся в Восточночешском зоопарке Двур-Кралове над Лабой

В работе приведены результаты гематологического и биохимического исследований периферической крови 6 взрослых волков (*Canis lupus*), 5 молодых волков из Восточночешского зоопарка Двур Кралове над Лабой. У упомянутых двух групп волков определяли средние величины численности красных телец, содержание

Table 12

Comparison of biochemical values in the blood serum of wolves (Canis lupus) with those reported for the dog (Canis familiaris)

Biochemical value compared	KIRK 1980		SOVA 1979		JAGOŠ, BOUDA 1981	
	a	b	a	b	a	b
Total bilirubin	/	●	/	●	/	●
Protein	●	●	●	●	●	●
Glucose	▲	▲	▲	▲	▲	▲
Creatinine	●	●	●	●	●	●
Urea	●	▲	●	●	●	▲
Triglycerides	● <sup>+) )</sup>	● <sup>+) )</sup>	N	N	▲	▲
Cholesterol	●	●	●	●	●	●
Alkaline phosphatase	▲	●	N	N	▲	▲
A S T	●	●	N	N	●	●
A L T	●	●	N	N	▲	●
Magnesium	▼	●	●	●	▼	●
Calcium	●	●	●	●	▼	▼
Phosphorus	▲	●	●	●	●	▼
Chlorides	▲	●	▲	●	▲	●
Sodium	●	●	●	●	▼	●
Potassium	●	●	●	▼	●	●

+ ) This value was not listed by KIRK (1980) using the data of N.Y.S. Veterinary College, Cornell University, but is quoted by BENTINCK-SMITH (1980).

/ = not evaluated

N = not mentioned by the author

For explanation of the symbols see Table 11.

гемоглобина, гематокрита, среднее количество гемоглобина красные тельца, среднюю концентрацию гемоглобина красные тельца, средний объем красные тельца, численность белых телец, представительство отдельных видов белых телец. В кровяной сыворотке определяли средние величины уровня белков, глюкозы, креатинина, мочевины, триглицеридов, холестерина, магния, кальция, фосфора, хлоридов, натрия, калия, активность щелочной фосфатазы, аминотрансферазы AST и ALT. У взрослых волков определяли также уровень общего билирубина, меди и цинка. В периферической крови молодых волков было установлено статистически значимое понижение количества красных телец, гематокрита и содержания гемоглобина, более высокое количество белых телец. Исходя из биохимических величин сыворотки крови, у молодых волков был установлен статистически значимый более низкий уровень креатинина, более высокий уровень холестерина и фосфора и более высокая активность щелочной фосфатазы.

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