HAEMATOLOGICAL INDICES IN FALLOW DEER

G. KOVÁČ, J. CIBEREJ, I. PAULÍKOVÁ, H. SEIDEL

Department of Internal Diseases of Ruminants and Swine,
University of Veterinary Medicine, Košice, Slovak Republic

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Abstract

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Dynamics of haematological indices (erythrocytes, leukocytes, haemoglobin, haematocrit, segmented and band neutrophils, eosinophils, basophils, lymphocytes, and monocytes) were studied in 11 male and 19 female fallow deer. The animals were shot at the game parks Rozhanovce and Rožňava-Betliar.

Average values of haematological indices in juvenile (younger than 2 years) and adult (over two years) fallow deer were as follows: Er - 10.95 and 9.84 T/l; Lc - 3.98 and 3.55 G/l; Hb - 13.12 and 13.08 g/dl; Hc - 0.48 and 0.49 l/l; Ns - 39.5 and 40.5 %; Nb - 4.5 and 6.4 %; Eo - 5.2 and 3.7 %; Ba - 0 and 0.2 %; Ly - 49.3 and 49.3 %; and Mo - 1.3 and 0.7 %, respectively. The differences between young and adult animals were not significant.

Similarly, no significant differences were recorded in the juvenile fallow deer when evaluated by their gender. On the other hand, in adult animals significant ($P<0.05$) differences were observed between male and female animals in Hb (11.07 and 13.89 g/dl, resp.) and hematocrit (0.43 and 0.51 l/l, resp.).

Seasonal changes were as follows ($P<0.05$): Er spring-autumn (average values 11.24 and 8.38 T/l, resp.), spring-winter (11.24 and 9.49 T/l); Lc spring-winter (3.97 and 2.5 G/l), summer-winter (4.64 and 2.50 G/l), and autumn-winter (5.53 and 2.50 G/l); Hb spring-summer (13.65 and 11.42 g/dl), spring-autumn (13.65 and 9.70 g/dl), summer-winter (11.42 and 14.17 g/dl), and autumn-winter (9.70 and 14.17 g/dl); Hc spring-summer (0.50 and 0.42 l/l), summer-winter (0.42 and 0.53 l/l), autumn-winter (0.44 and 0.53 l/l); Nb spring-summer (2.8 and 8.0 %), spring-autumn (2.8 and 6.6 %), summer-winter (8.0 and 4.3 %); Ly spring-winter (53.1 and 47.0 %); Mo spring-winter (2.2 and 0.2 %). These findings indicate a transition period in feeding. In winter, there is an increased proportion of dry matter in the diet due to nipping off tree twigs, and feeding hay and other dried foods. The change from winter to spring feeding is related to feeding green pasture-grasses and winter corns. As in domesticated ruminants, it may be suggested that there is a period of adaptation of rumen microflora and microfauna. This period is frequently associated with diarrhoea, which may cause the changes in haematological profile.

Fallow deer, age, gender, season of the year, erythrocytes, leukocytes, haemoglobin, haematocrit

Health management and production potential of livestock is closely related to application of effective diagnostic and preventive measures. Rearing of fallow deer in game parks, farms, and free nature is of increasing importance. Moreover, game animals serve as a valuable bioindicator of environment quality (Mlynarčíková et al. 1995; Legáth et al. 1996). Therefore, clinical examination and metabolic tests (haematological, macro- and micro-elements, enzymatic, protein, energetic, vitamin, ruminal, and urinary profiles) in fallow deer are also inevitable to obtain a complex evaluation of their environment (including nutrition).

By this approach, it is possible to detect metabolic disorders (lack or surplus of energy, protein, macro- and micro-elements) and increased exposure to risk elements in industrial areas or areas with high level of chemization.

Archaeological findings indicate the presence of fallow deer in Middle Europe in the past two inter-glacial ages. During the last glacial age, fallow deer disappeared from this region. Spotted fallow deer (*Dama dama* Linné 1785) survived in Middle Asia, particularly in

Taurus mountains (present Turkey) and the island of Rhodos in Mediterranean Sea. Mesopotamic fallow deer (*Dama mesopotamica* Brooke, 1885), the relative of spotted fallow deer, was described only 110 years ago in border regions of Iran and Iraq. Spotted fallow deer was reintroduced to Europe with Roman legions. To the territory of Slovakia, fallow deer was introduced probably in the 13th century during establishment of new royal game parks at Zvolen and Gemer regions. Contrary to endangered Mesopotamic fallow deer, world population of spotted fallow deer is about 200 000 animals (Heideman 1987). Following the preceding reports on fallow deer populations in England and Germany, Randi and Apollonio (1988) confirmed low variability in biochemical indices of the European population of fallow deer.

The aim of the present work was to complete the existing data, and compare juvenile and adult animals. We further studied their biochemical indices during four seasons of the year.

Materials and Methods

The studies were performed at a facility of the UVM Košice (game park Rozhanovce, 501 ha, 0.45 animal per ha) and game park Betliar (1 298 ha, 0.49 animal per ha) in Eastern Slovakia during the years 1993-1995. The fallow deer population at Rozhanovce came from Hungarian Guylai Farm; the Betliar population is mostly of hybrid origin.

During one year (January-December), fallow deer (11 males and 19 females) were shot dead. Blood was collected immediately from jugular vein into beakers with anticoagulant (K_3EDTA) for haematological examination.

The blood samples were analysed within 12 hours using standard haematological equipment. Values of erythrocytes (Er), leukocytes (Lc), haemoglobin (Hb), and haematocrit (Hc) were measured by cell counter (Serono 150+ Analyser). Differential leukocyte count (segmented neutrophils - Ns, band neutrophils - Nb, eosinophils - Eo, basophils - Ba, lymphocytes - Ly, and monocytes - Mo) were determined microscopically on blood smears stained by Pappenheim (Slanina et al. 1993).

The results are presented as mean values (x), sum of values, minimal and maximal values, standard deviation (SD), and standard error of mean (SEM). Student's t-test was used to assess the differences between the groups (Excel 5.0).

Results

The animals were divided into two groups: juvenile fallow deer - aged up to 2 years, and adult animals - older than 2 years. These groups were evaluated by their gender, male and female; and season of the year, i.e. spring, summer, autumn, and winter. The results are presented in Tables 1-10.

Table 1
Haematological indices in fallow deer
(juvenile animals, n = 16)

	Er T/l	Lc G/l	Hb g/dl	Hc l/l	Ns %	Nb %	Eo %	Ba %	Ly %	Mo %
x	10.95	3.98	13.12	0.48	39.5	4.5	5.2	0	49.3	1.3
sum	175.2	63.7	210.0	7.71	633	72	84	0	789	21
min.	6.48	2.00	6.9	0.38	19	0	0	0	38	0
max.	13.80	8.7	16.5	0.58	50	28	18	0	64	4
SD	2.05	1.48	2.35	0.05	8.7	6.7	5.0	0	7.3	1.2
SEM	0.54	0.37	0.58	0.01	2.1	1.6	1.2	0	1.8	0.3

Table 2
Haematological indices in fallow deer
(adult animals, n = 14)

	Er T/l	Lc G/l	Hb g/dl	Hc 1/1	Ns %	Nb %	Eo %	Ba %	Ly %	Mo %
x	9.84	3.55	13.08	0.49	40.5	6.4	3.7	0.2	49.1	0.7
sum	137.78	49.70	183.20	6.96	567	90	52	3	642	10
min.	8.38	2.0	9.2	0.36	34	0	1	0	39	0
max.	12.12	8.6	15.5	0.58	50	10	8	1	55	4
SD	1.36	1.59	2.08	0.07	5.3	2.4	2.3	0.4	4.1	1.3
SEM	0.36	0.42	0.55	0.01	1.4	0.6	0.6	0.1	1.1	0.3

We observed non-significant differences between young and adult fallow deer animals in all indices of the haematological profile.

Table 3
Haematological profile in fallow deer
(juvenile males, n = 7)

	Er T/l	Lc G/l	Hb g/dl	Hc 1/1	Ns %	Nb %	Eo %	Ba %	Ly %	Mo %
x	10.08	4.14	12.47	0.47	42.5	3.0	3.7	0	48.8	1.7
sum	70.57	29.00	87.3	3.32	298	21	26	0	342	12
min.	6.48	2.0	6.9	0.38	36	0	0	0	44	0
max.	12.36	8.7	15.0	0.56	49	6	11	0	53	3
SD	2.54	2.23	2.87	0.06	4.9	2.3	3.5	0	3.2	0.9
SEM	0.96	0.84	1.08	0.02	1.8	0.8	1.3	0	1.2	0.3

Table 4
Haematological profile in fallow deer
(juvenile females, n = 9)

	Er T/l	Lc G/l	Hb g/dl	Hc 1/1	Ns %	Nb %	Eo %	Ba %	Ly %	Mo %
x	11.57	3.85	13.63	0.48	37.2	5.6	6.4	0	49.6	1
sum	104.18	34.70	122.70	4.39	335	51	58	0	447	9
min.	9.46	3.0	10.7	0.39	19	0	2	0	38	0
max.	13.80	4.5	16.5	0.58	50	28	18	0	64	4
SD	1.56	0.56	1.88	0.05	10.4	8.8	5.9	0	9.5	1.4
SEM	0.52	0.18	0.62	0.01	3.4	2.9	1.9	0	3.1	0.4

Statistically non-significant differences in all haematological indices were observed between juvenile male and female fallow deer animals.

Table 5
Haematological profile in fallow deer
(adult males, n = 4)

	Er T/l	Lc G/l	Hb g/dl	Hc l/l	Ns %	Nb %	Eo %	Ba %	Ly %	Mo %
x	9.05	3.77	11.0[a]	0.43[b]	38.7	8.2	4.2	0.5	48	0.2
sum	36.20	15.10	44.30	1.72	155	33	17	2	192	1
min.	8.86	3.4	10.6	0.36	36	6	2	0	45	0
max.	9.24	4.2	11.6	0.48	43	10	8	1	51	1
SD	0.17	0.33	0.45	0.05	3.4	1.7	2.6	0.5	2.9	0.5
SEM	0.08	0.16	0.22	0.02	1.7	0.8	1.3	0.2	1.4	0.2

No significant differences were found between male and female animals in Er, Lc, Ns, Nb, Eo, Ba, Ly, and Mo. However, significant differences ($P<0.5$) were observed in Hb[a] and Hc[b] between these two groups.

Regarding the season of the year, we observed the following significant ($P<0.05$) differences of haematological indices: Er - spring:autumn[c], spring:winter[c]; Lc - spring:winter[d], summer:winter[d], autumn:winter[d]; Hb - spring:summer[e], spring:autumn[e], summer:winter[e], autumn:winter[e]; Hc - spring:summer[f], summer:winter[f], autumn:winter[f]; Nb - spring:summer[g], spring:autumn[g], summer:winter[g]; Ly - spring:winter[h]; Mo - spring:winter[ch]. There were no significant seasonal differences in Ns, Eo, and Ba.

Discussion

Rearing and improvement of wild animals requires careful management of their environment (biotope, composition of food, water sources, etc.) as well as biochemical indices of the animals (haematological, macro- and micro-elements, needs for energy, protein, etc.)

There are numerous literature data on domesticated and wild animals. In these studies, various points of view were used such as animal species, genus, age, gender, season of the year (closely related to qualitative and quantitative nutritional changes), stage of pregnancy, immobilization methods, catching, keeping, shooting, etc. (Vrzgula et al. 1991; Kováč et al. 1986; Slanina et al. 1993; Jelínek et al. 1984; Abaigar 1993; Kocan et al. 1981; Silva et al. 1993a; Reitkerk et al. 1994; Váhala et al. 1994; Wolkers et al. 1994).

Table 6
Haematological profile in fallow deer
(adult females, n = 10)

	Er T/l	Lc G/l	Hb g/dl	Hc l/l	Ns %	Nb %	Eo %	Ba %	Ly %	Mo %
x	10.15	3.46	13.8[a]	0.51[b]	41.2	5.7	3.5	0.1	49.6	0.9
sum	101.58	34.60	138.90	5.14	412	57	35	1	496	9
min.	8.38	2.0	9.2	0.38	34	0	1	0	39	0
max.	12.12	8.6	15.5	0.58	50	8	8	1	55	4
SD	1.50	1.90	1.92	0.06	5.9	2.3	2.2	0.3	4.5	1.5
SEM	0.47	0.60	0.60	0.02	1.8	0.7	0.7	0.1	1.4	0.4

During our one year study, assessment of haematological indices in fallow deer showed increased average values of erythrocytes, haemoglobin and haematocrit compared to reference values in cattle (young and adult fallow deer population: Er - 10.95 and 9.84 T/l; Hb - 13.12 and 13.08 g/dl; Hc - 0.48 and 0.49 l/l, respectively; compared with cattle reference values: Er - 5.1 - 7.9 T/l, Hb - 9.3 - 11.7 g/dl, Hc - 0.30 - 0.40 l/l). These findings may be related to stress during capture, restraint, or shooting of the animals (as reported in previous articles - Cimbal et al. 1985, 1990). It is associated with adrenaline-mediated contraction of the spleen (Wilson and Pauli 1982). Other possible explanation may be physiological adaptation in connection with sudden reaction in the form of escape from the place of danger. According to Mautz et al. (1980) and Kocan et al. (1981) chemical and physical immobilization had no effects on haematological indices in white-tailed deer.

In young fallow deer, comparing values after birth and at three months of age, we found (Cimbal et al. 1990) an increase in Er, Hb, and Hc (Er - from 7.87 to 11.99 T/l; Hb - from 8.68 to 11.05 g/dl; Hc - from 0.34 to 0.49 l/l). This is probably associated with development and function ability of haematopoietic system at an early age. Chapman (1977) reported age differences in red blood cell indices. In the young, these indices reached the values of adult animals approximately at 6 months of age (determined also in white-tailed deer and mountain roebuck).

Table 7
Haematological profile in fallow deer
(spring 21. 3.–20. 6., n = 10)

	Er T/l	Lc G/l	Hb g/dl	Hc l/l	Ns %	Nb %	Eo %	Ba %	Ly %	Mo %
x	11.24[c]	3.97[d]	13.65[e]	0.50[f]	38.1	2.8[g]	3.8	0	53.1[h]	2.2[ch]
sum	101.20	39.70	136.50	5.00	381	28	38	0	531	22
min.	9.46	2.9	10.7	0.39	22	0	1	0	40	0
max.	12.12	5.0	15.5	0.58	50	6	10	0	64	4
SD	0.94	0.64	1.68	0.06	7.7	2.3	2.9	0	7.0	1.3
SEM	0.31	0.20	0.53	0.01	2.4	0.7	0.9	0	2.2	0.4

In this report we observed no statistically significant differences in the above mentioned indices within the one year study of comparison between juvenile (younger than 2 years) and adult (older than 2 years) fallow deer. Similarly, we recorded no significant difference between the male and female juvenile animals. On the other hand, in the adult population there were significant differences in Hb and Hc related to gender with higher average values in females. Chapman and Chapman (1982) observed no significant differences in Hb, Er, and Hc in relation to age and sex of fallow deer. However, in our study, values in females were markedly higher than in males. We suggest that in the fallow deer population older than 2 years these differences may be caused by effects of year season and gender.

Regarding the white blood picture, as reported in previous studies (Cimbal et al. 1986), after catching of fallow deer there are substantially lower numbers of leukocytes compared with domesticated ruminants (young and adult fallow deer: Lc - 3.98 and 3.65 G/l, resp.; cattle below 3 months - 6.2 - 11.0 G/l; adult cattle - 6.0 - 10.0 G/l; sheep - 5.1 - 11.1 G/l; goats - 8.8 -14.3 G/l). However, these findings are not indicative of clinical leukopenia. It is

Table 8
Haematological profile in fallow deer
(summer 21. 6.–22. 9., n = 5)

	Er T/l	Lc G/l	Hb g/dl	Hc l/l	Ns %	Nb %	Eo %	Ba %	Ly %	Mo %
x	10.45	4.64[d]	11.42[e]	0.42[f]	39.8	8.0[g]	4.8	0.4	47	0
sum	52.26	23.20	57.10	2.12	199	40	24	2	235	0
min.	8.86	3.2	9.2	0.36	35	7	2	0	39	0
max.	13.6	8.6	13.8	0.49	50	10	8	1	52	0
SD	1.98	2.24	1.68	0.05	6.0	1.2	2.9	0.5	5.1	0
SEM	0.88	1.00	0.75	0.02	2.6	0.5	1.3	0.2	2.3	0

suggested that response of leukocytes in wild ruminants is lower than in the aforementioned farm animals (Wilson and Pauli 1982; Chapman and Chapman 1982; Hawkey et al. 1984).

Our previous studies in captured fallow deer (Cimbal et al. 1986) showed significant increase in leukocytes (from average 4.25 G/l in April to 7.47 G/l in May) in females in advanced pregnancy, followed by their decrease after parturition (June - 4.33, September - 4.53, and November - 4.28 G/l). These findings require a more detailed study, particularly in close relation to hormonal activity during reproduction cycle (Ostró and Toropila 1995a, b).

In our study, contrary to the report of Wilson and Pauli (1982) on haematological profile in red deer, we did not confirm a higher percentage of neutrophils compared with that of lymphocytes. Similarly, we did not observe significant differences in percentual values of other granulocytes, i.e. Eo, Ba, and Mo that were similar to those found in domesticated animals.

Our previous studies (Cimbal et al. 1986) revealed that the period of parturition in female fallow deer (June) was characterized by an increase in percentage of eosinophils (in average to 17.67 %), decrease in percentage of segmented (from average 66.17 % in May to 36.33 % in June) and band (form 0.67 % in May to 0.33 % in June) neutrophils, and increase in percentage of lymphocytes (from 29.33 % in May to 44.33 % in June). During the following period we observed continuous recovery of these indices to the values found before parturition. At the same time, a decrease in leukocyte counts was found in the young in the

Table 9
Haematological profile in fallow deer
(autumn 23. 9.–20. 12., n = 3)

	Er T/l	Lc G/l	Hb g/dl	Hc l/l	Ns %	Nb %	Eo %	Ba %	Ly %	Mo %
x	8.38[c]	5.53[d]	9.7[e]	0.44[f]	39	6.6[g]	4.0	0.3	49	1
sum	25.14	16.60	29.1	1.32	117	20	12	1	147	3
min.	6.94	3.7	6.9	0.38	36	5	3	0	46	0
max.	9.24	8.7	11.6	0.48	43	9	5	1	51	2
SD	1.25	2.75	2.47	0.05	3.6	2.0	1.0	0.5	2.6	1
SEM	0.72	1.58	1.42	0.03	2.0	1.2	0.5	0.3	1.5	0.5

month of birth as compared with the next blood sampling in September (from 5.21 to 3.65 G/l), increase in eosinophils from 0.7 to 3.0 %, decrease in segmented neutrophils from 66.0 to 41.5 %, and increase in lymphocytes from 29.42 to 53 %. We suggest that dynamics of aforementioned indices indicate their dependence on stage of pregnancy and age of newborns. These findings add to information published earlier (English and Lepherd 1981; Wilson and Pauli 1981; Rani and Apoloni 1998) on white blood picture differences between domesticated and wild ruminants.

Table 10
Haematological profile in fallow deer
(winter 21. 12.–20. 3., n = 8)

	Er T/l	Lc G/l	Hb g/dl	Hc l/l	Ns %	Nb %	Eo %	Ba %	Ly %	Mo %
x	9.49^{c}	2.5^{d}	14.17^{e}	0.53^{f}	44.1	4.3^{g}	5.3	0	47^{h}	0.2^{ch}
sum	75.96	20.0	113.40	4.27	353	35	43	0	376	2
min.	6.48	2.0	11.4	0.43	39	0	2	0	38	0
max.	12.40	3.1	15.2	0.58	50	8	18	0	52	1
SD	1.99	0.39	1.23	0.04	3.7	2.9	5.9	0	4.4	0.4
SEM	0.70	0.14	0.43	0.01	1.3	1.0	2.1	0	1.5	0 . 1

Compared with the aforementioned information, in our study of haematological profile in fallow deer during the four seasons of the year, we found statistically significant differences (P<0.5) in mean values of erythrocytes, leukocytes, haemoglobin, haematocrit, band neutrophils, lymphocytes, and monocytes. These differences indicate the importance of transition period of feeding with changes in diet composition. Winter period is characterized by increased proportion of dry matter in the diet (nipping off tree twigs, feeding hay and other dried foods). Shift from winter to spring feeding is related to feeding green pasture - grasses and winter corns. As in domesticated ruminants, it may be suggested that there is some period of adaptation of rumen micro-flora and micro-fauna. This period is frequently associated with diarrhoea, which may cause the changes in haematological profile (Kováč et al. 1992).

Hematologické ukazovatele u danielej zveri

Na základe doterajších poznatkov o hodnotách ukazovateľov hematologického profilu u danielej zveri sme študovali ich dynamiku (erytrocyty, leukocyty, hemoglobín, hematokrit, segmentované neutrofily, tyčinkové neutrofily, eozínofily, bazofily, lymfocyty, monocyty) u 11 ks samčieho a 19 ks samičieho pohlavia po riadnom a mimoriadnom odstrele v podmienkach zvernice v Rozhanovciach a vo zvernici Rožňava-Betliar.

Priemerné hodnoty pri porovnaní mladej danielej zveri (do veku 2 rokov) a dospelej danielej zveri (vo veku nad 2 roky) dosahovali pri: Er - 10,95 resp. 9,84 T/l; Lc - 3,98 resp. 3,55 G/l; Hb - 13,12 resp.13,08 g/dl; Hk - 0,48 resp. 0,49 l/l; Ns - 39,5 resp. 40,5 %; Nty - 4,5 resp. 6,4 %; Eo - 5,2 resp. 3,7 %; Ba - 0 resp. 0,2; Ly - 49,3 resp. 49,3; Mo - 1,3 resp. 0,7. Zistené rozdiely v rámci skupín neboli štatisticky významné.

Obdobne štatisticky nevýznamné rozdiely sme zaznamenali pri posúdení vyššie uvedených ukazovateľov z pohľadu rozdielneho pohlavia u danielej zveri do veku 2 rokov. Na rozdiel od uvedeného sme zistili pri porovnaní dospelých samcov a samíc danielej zveri štatisticky významné rozdiely (P < 0,05) len pri Hb - 11,07 resp. 13,89 g/dl a pri Hk - 0,43 resp. 0,51 l/l. Oproti vyššie popísaným poznatkom pri zhodnotení ukazovateľov hematologického profilu danielej zveri z pohľadu sezónnosti sme zistili štatisticky významné rozdiely (P < 0,05) pri posúdení hodnôt Er: jar - jeseň (priemerné hodnoty 11,24 resp. 8,38 T/l), jar - zima (11,24 resp. 9,49 T/l); Lc : jar - zima (3,97 resp. 2,5 G/l), leto - zima (4,64 resp. 2,50 G/l) a jeseň - zima (5,53 resp. 2,50 G/l); Hb : jar - leto (13,65 resp. 11,42 g/dl), jar - jeseň (13,65 resp. 9,70 g/dl), leto - zima (11,42 resp. 14,17 g/dl) a jeseň - zima (9,70 resp. 14,17 g/dl); Hk : jar - leto (0,50 resp. 0,42 l/l), leto - zima (0,42 resp. 0,53 l/l), jeseň - zima (0,44 resp. 0,53 l/l); Nty : jar - leto (2,8 resp. 8,0 %), jar - jeseň (2,8 resp. 6,6 %), leto - zima (8,0 resp. 4,3 %); Ly : jar - zima (53,1 resp. 47,0 %); Mo : jar - zima (2,2 resp. 0,2 %). Uvedené skutočnosti poukazujú zvlášť na prechodné obdobie v zložení prijímaného krmiva. Zimné obdobie je charakterizované vyšším podielom sušiny v prijímanej potrave, ktorá pochádza z ohryzu, prikrmovania senom, letninou. Prechod zo zimného obdobia na jarné súvisí so započatím príjmu zeleného porastu - tráv a ozimín. Tak ako u domácich prežúvavcov možno predpokladať so zreteľom na zložitý žalúdok určité obdobie adaptácie bachorovej mikrofauny a mikroflóry, ktoré je často sprevádzané hnačkou, čo môže byť príčinou zmien v hodnotách ukazovateľov hematologického profilu.

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Address for correspondence:
Prof. MVDr. G. Kováč, DrSc.
University of Veterinary Medicine
Komenského 73
SK-041 81 Košice
Slovak Republic

Phone: 421 95 63 385 20
Fax: 421 95 63 236 66
E-mail: kovacg@vsvnov.uvm.sk