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**Original Scientific Paper****EFFECT OF ECOLOGICAL FACTORS ON THE BLOOD TESTS FOR DOGS IN THE TUZLA CANTON AREA****Elvira HADŽIAHMETOVIĆ JURIDA<sup>1\*</sup>, Jasmin FERIZBEGOVIĆ<sup>1</sup>, Marija VUČIĆEVIĆ<sup>1\*\*</sup>, Sandra ĐAPO<sup>2</sup>**<sup>1</sup> The Faculty of Natural Sciences and Mathematics University of Tuzla, Tuzla, Bosnia and Herzegovina<sup>2</sup> ZADA Pharmaceuticals, Lukavac, Bosnia and Herzegovina**\*\*** Student of Second Cycle Degree Programme, Ecology and Environmental Protection studies, Tuzla, Bosnia and Herzegovina**\*** Corresponding author: elvira.h.jurida@untz.ba

**Abstract:** Blood test analysis, i.e. determination of the number of erythrocytes, leucocytes, thrombocytes and other blood elements is nowadays used quite frequently for diagnostic purposes. Hematological parameters and body mass are reliable indicators of the general condition of the organism, and serve as an indirect indicator of the environment of the living organism. Hematological parameters and body mass were examined in a total of 60 dogs of various breeds, including mixed breeds. The purebred dogs included 30 dogs while the mixed breed group included another 30 dogs from the territory of Tuzla Canton. The examined dogs differed in the manner of nutrition and their living environment, and therefore, the results show a variety of deviations that were considered later on and further analysed in order to determine their causes. All examinations were conducted, observed and processed in accordance with relevant ecological environmental factors in the period of autumn of 2016.

The aim of this study was to determine the influence of environmental factors in the study period on the hematological parameters of both examined groups of dogs.

After the analysis of the blood test with the use of the hemogram for owned dogs and asylum dogs, that have been treated and kept in various manners, and the statistical processing of data obtained, it was concluded that the dogs with increased number of eosinophils had a parasitic disease. A large number of owned dogs had parasitic diseases due to incorrect usage of antiparasitics and not so frequent visits to veterinarians. The dogs that were under constant medical supervision were completely healthy.

**Key words:** ecological factors, dogs, blood, hematogram, parasites

**INTRODUCTION**

Various theories (Ebenman and Persson, 1988) explain the influence of ecological factors on population size. Population size is regulated by factors that do not depend on population

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density. These factors are called abiotic factors and include climatic and edaphic factors, atmospheric weather, natural disasters (floods, fires, volcanic eruptions). Factors that depend on population density are called biotic factors and are presented by resources such as food, water, space, predation and competition. These biotic and abiotic factors are very important for the living organisms survival (Šantić, 2013). Biotic conditions are the pattern and time of feeding dogs, and the space in which dogs live. The abiotic factor is period in which the analyzes were performed, in this case in the autumn including October, November and first decade of December. In this paper, special attention is given to the influence of parasites, as a biotic factors.

Parasites (Greek. para = beside i sitos = food) are animals that live at the expense of another species individuals, animal or plant, and are biologically and ecologically closely related to it for a longer or shorter period of their life cycle. Parasites are fed by the body fluids, tissues or digested food of their host, that was prepared by host for its diet. A specific characteristic of parasites is that they use the host for their diet repeatedly and for a longer period of time (Čanković and Jažić, 1998). According to length of stay of the parasite in the host or on it, the parasites are divided in to occasional and permanent parasites.

Blood is the most complex body fluid of animal organisms, and is characterized by homeostasis i.e. stability in terms of organic and inorganic composition. The constancy of the blood composition is very important for the normal function of the organism. Abiotic and biotic factors have direct impact on the complete blood count and body mass of living organisms. Thus, unfavorable abiotic and biotic factors may lead to a numerous health problems. Blood also participates in the body temperature regulation, enables maintenance of constant concentration of water and electrolytes in cells, regulates the concentration of hydrogen ions in the body and participates in defense against microorganisms (Dukes, 1970).

Complete blood count in dogs is an important factor in disease detection. However, the impact of environmental factors on the complete blood count in dogs has been insufficiently investigated.

The following goals are set in this paper: to determine the impact of environmental factors, in the study period, on the hematological parameters of both examined groups of dogs and investigate the impact of parasites as biotic factor on complete blood count of owner dogs during the study period.

## MATERIALS AND METHODS

Hematological parameters and the health condition of 60 examined dogs were determined in this study. Blood analysis was done at the Public Company Veterinary Station Tuzla in the autumn period, October, November and the first decade of December. The study included a total of 60 dogs. Dogs were divided into two groups:

Group A represented dogs from shelter. Out of 30 dogs taken as a sample, 25 dogs were mix breeds – the parents breed could not be reliably determined, while the other 5 dogs

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were assumed to be purebred – which also was not reliably determined due to lack of the pedigree. The youngest dog in this group was 5 months old while the oldest dogs were 8 years old. Stray dog, in this case housed in an asylum, are thought to live an average of 2 to 5 years. A total of 6 dogs out of 30 in this group had an above-average life expectancy. The body mass corresponded to the size and age of the dogs so there were no undernourished or obese dogs in the above group.

Group B represents owner dog. Out of 30 dogs taken as a sample, 2 dogs were mixed breeds- the parents breed could not be reliably determined, while the other 28 dogs were purebred – they had pedigrees. The youngest dog in this group was 2 months old while the oldest dogs were 10 years old. The oldest dogs belonged to small breeds characterized by a longer lifespan. In general, large dogs live an average of 8 to 10 years, while small dogs live an average of 12 to 14 years. The body mass corresponded to the size and age of the dogs, so there were no undernourished or obese dogs in the mentioned group.

Blood for hematological analyses was taken from dogs vein in the front right leg (*v. radialis*). The sample was prepared for analyses by adding the EDTA anticoagulant in the 2ml of blood in a test tube. After this procedure, the blood was homogenized and drawn into a tube with an automatic pipette. The tubes were then placed in the centrifuge.

Centrifugation is an important sequence in the preanalytical phase, priority should be given to separating serum from whole blood immediately after coagulation, as prolonged contact with coagulum may lead to decrease or increase in certain analytes concentrations in the tested serum.

Centrifugation of coagulated blood in order to obtain serum was performed after coagulation was complete. Centrifugation of coagulated blood to obtain serum as well as anticoagulant blood to separate plasma was performed by centrifugal force (g) from 1000 to 2000 g, 10 to 15 minutes. Samples were centrifuged within two hours after sampling. Certain analytes may be significantly changed if they are not separated from blood cells (potassium increases, glucose decreases, etc.).

The centrifuged sample was analyzed for hematological and biochemical parameters using Idexx Hematology Biochemie, i.e. the analyzer for hematological and biochemical parameters which showed the obtained values in the form of hemograms. Hematocrit (HCT), Hemoglobin (HGB), Mean corpuscular volumen (MCV), Mean corpuscular haemoglobin (MCH), Mean corpuscular haemoglobin concentration (MCHC), Platelets (PLT), Red blood cell count (RBC), White blood cell count (WBC), Reticulocytes (Retics), Neutrophils (NEUT), Eozinophyls (EOS), Limfocite to monocite ratio (L/M), were examined as hematological parameters.

For statistical analysis of the obtained values, the program for statistical processing, SPSS, was used. The Kolmogorov-Smirnov test was used to compare the distribution between groups.

Descriptive statistics was used to show some basic values within groups and the correlation method was used to compare the values of the observed parameters between groups. The

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Student's t-test was used to determine the significance between the mean values of the observed groups. Mann-Whitney U-test is a nonparametric test that was used for uneven distribution between the two observed samples.

## RESULTS AND DISCUSSION

The conducted study included hematological analyses and determination of the health condition performed in 30 examined dogs from the shelter and 30 owner dogs (60 in total). The blood analysis was done in the Public Company Veterinary Station Tuzla in the period of autumn, in the months of October, November and the first half of December.

Average monthly temperatures (table 1.) during October, November and first decade of December 2016 were normal, except in November when temperatures were higher than in previous years. The values of average monthly temperatures and air pressures are presented in table 1.

**Table 1.** Monthly temperature data

TUZLA year 2016 =  $\phi 44^{\circ}32' 31''$  i  $\lambda 18^{\circ} 41' 06''$  Hs=305mm Hbm=306,5 m, ht=2,0, hr=1,5

Month	Atmospheric pressure				Air temperature								Extreme temperatures				
	P (hPa)				T (°C)												
	7:00	14:00	21:00	Mean	7:00	14:00	21:00	Mean	Tmax	Tmin	Tmin5	Tmin5	Date	T <sub>max</sub>	Date	T <sub>min</sub>	Date
October	985.2	984.8	985.6	985.2	6.7	15.1	8.8	9.9	15.8	5.7	4.5	-0.3	06	26.4	25	-0.6	06
November	983.6	983.1	983.5	983.4	3.5	12.2	6.3	7.1	13.7	2.2	1.5	-8.6	30	23.0	06	-7.1	30
December	994.4	993.8	994.3	994.2	-2.6	4.7	-0.7	0.2	5.3	-3.7	-5.1	-10.9	14	13.8	11	-9.1	31

Temperature or heat is one of the ecological factors that is often studied both in nature and in experimental-laboratory conditions, where the influence of temperature on the animals activity, some metabolic processes and adaptation is usually monitored (Walter, 1970).

In tables 2. and 3., vertically – dogs listed under ordinal numbers and horizontally – results of the examined parameters for Hematocrit (HCT), Hemoglobin (HGB), Mean corpuscular volumen (MCV), Mean corpuscular haemoglobin (MCH), Mean corpuscular haemoglobin concentration (MCHC), Platelets (PLT), Red blood cell count (RBC), White blood cell count (WBC), Reticulocytes (Retics), Neutrophyls (NEUT), Eozinophyls (EOS), Lymphocyte to monocyte ratio (L/M).

The highest obtained values are marked in red and the lowest obtained values in the conducted study are marked in green.

A hemogram or complete blood count (CBC) is used as a screening test to establish disorders like anemia, infection and many other diseases. It is actually a test profile that examines different parts of the blood and includes the following: Hematocrit (HCT) which measures the percentage of red blood cells in a certain blood volume. Hemoglobin (HGB)

measures the amount of oxygen – carrying protein in the blood. The hemoglobin breakdown creates the color bilirubin, which is excreted in the bile. The iron that is released can be used to synthesize new hemoglobin molecules or stored in iron stores in the body. This process is called erythropoiesis, which is regulated by the tissue's need for oxygen. Accelerated erythrocyte formation occurs in those conditions in which there is an absolute or relative lack of oxygen (as anemia during prolonged stay at high altitudes, diseases of respiratory and circulatory system) (Petrović, 1991). The Mean corpuscular volume (MCV) is a measurement of the average size of red blood cells. MCV is elevated when red blood cells are larger than normal (macrocytes), for example in anemia caused by vitamin B12 deficiency. When MCV is reduced, red blood cells are smaller than normal (microcytes) as seen in iron deficiency anemia. Mean corpuscular hemoglobin (MCH) is the calculation of the average amount of oxygen-carrying hemoglobin within red blood cells. Macrocytic red blood cells are large and they tend to have a higher MCH, and microcytic red blood cells will have a lower value in this case. Mean corpuscular hemoglobin concentration (MCHC) is the calculation of the average hemoglobin concentration in red blood cells. Decreased MCHC values (hypochromia) are seen in conditions in which hemoglobin is abnormally diluted within red blood cells, such as iron deficiency and thalassemia. Increased MCHC values (hyperchromia) are seen in conditions in which hemoglobin is abnormally concentrated within red blood cells. PLT is the number of platelets in a given blood volume. Increasing and decreasing may indicate inappropriate bleeding or clotting process. The number of red blood cells (RBC) is the actual number of red blood cells per blood volume. Increases and decreases may indicate inappropriate living condition. The number of white blood cells (WBC) is the actual number of white blood cells per blood volume. Increases and decreases may indicate inadequate living condition. Retics is the percentage of reticulocytes in the blood, or the percentage erythrocytes that are in the process of formation.

If increased and decreased values of eosinophils and neutrophils appear in the hematogram, these may indicate the following: Eosinophils – increased (eosinophilia) occur in asthma and allergic diseases, parasitic infestations, skin diseases, urticaria, eczema, malignant diseases (including eosinophilic leukemia), radiation, Loffler syndrome, radiation syndrome, and during recovery from infection. Hypereosinophilic syndrome is seen in the development of final organ damage (restrictive cardiomyopathy, neuropathy, hepatosplenomegaly). Neutrophils - increased (neutrophilia) occur in bacterial infections, trauma, burns, bleeding, inflammation, heart attack, taking certain medications (eg corticosteroids). Decreased (neutropenia) is present in viral infections, brucellosis, typhus, tuberculosis, septicemia, hypersplenism, lupus erythematosus, vitamins B12 deficiency and bone marrow disorders (Jovanović, 1986).

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**Table 2.** Haematological parameters in dogs from shelters

TEST ORDINAL NUMBER	HCT (%)	HGB (g/dL)	MCHC (g/dL)	WBC (109/l)	GRANS (109/L)	%GRANS (%)	NEUT (109/L)	EOS (109/l)	L/M (109/l)	%L/M (%)	PLT (109/l)	Retics (%)
1	49.3	17.1	34.7	9.1	6.5	71	5.8	0.7	2.6	28	334	0.4
2	46.6	14.7	31.5	11.9	9.9	83	/	/	2.0	17	427	1.4
3	34.8	11.2	32.2	11.7	10.2	87	9.0	1.2	1.5	13	552	0.8
4	46.5	15.1	32.5	15.1	10.9	72	/	/	4.2	28	445	0.6
5	50.4	14.9	29.6	10.2	7.9	77	/	/	2.3	23	440	0.3
6	46.0	15.2	33.0	14.9	12.5	84	/	/	2.4	16	761	/
7	45.5	15.8	34.7	10.1	8.6	85	3.9	4.7	1.5	15	435	0.9
8	50.6	18.2	36.0	9.5	8.0	84	/	/	1.5	16	311	0.9
9	46.6	15.0	32.2	11.6	9.9	85	/	/	1.7	15	599	0.7
10	37.6	13.0	34.6	10.1	9.1	90	/	/	1.0	10	391	/
11	48.8	14.9	30.5	17.6	8.9	51	/	/	8.7	49	488	4.0
12	49.4	16.4	33.2	18.1	15.6	86	/	/	2.5	14	434	0.5
13	35.5	11.6	32.7	11.0	8.3	75	2.5	5.8	2.7	25	448	2.3
14	43.0	14.7	34.2	10.9	8.6	79	/	/	2.3	21	387	1.5
15	35.5	11.5	32.4	15.5	10.9	70	/	/	4.6	30	512	/
16	43.5	14.3	32.9	15.3	12.4	81	/	/	2.9	19	546	0.2
17	49.6	16.8	33.9	20.3	17.7	87	15.5	2.2	2.6	13	319	0.4
18	35.2	11.5	32.7	12.0	8.7	72	/	/	3.3	28	454	2.1
19	52.0	18.0	34.6	10.2	7.9	77	/	/	2.3	23	334	2.0
20	46.0	15.8	34.3	7.5	6.3	84	1.7	4.6	1.2	16	306	0.2
21	36.7	12.4	33.8	56.1	25.0	45	/	/	31.1	55	51	0.3
22	49.7	17.9	36.0	8.1	5.7	70	3.1	2.6	2.4	30	278	1.2
23	46.8	16.4	35.0	9.9	7.3	74	/	/	2.6	26	260	3.3
24	44.4	15.4	34.7	7.5	5.6	75	2.6	3.0	1.9	25	453	/
25	39.4	11.6	29.4	20.6	18.3	89	/	/	2.3	11	746	3.7
26	30.2	11.0	36.4	5.9	4.7	80	2.3	2.4	1.2	20	509	0.2
27	32.7	10.3	31.5	75.5	48.5	64	47.0	1.5	27.0	36	46	0.4
28	36.1	11.8	32.7	12.0	9.5	79	/	/	2.5	21	387	2.5
29	37.9	12.4	32.7	10.0	8.5	85	/	/	1.5	15	164	2.5
30	52.1	17.6	33.8	18.6	8.3	45	6.0	2.3	10.3	55	45	0.4
Mean value	45.89	14.41	33.28	15.89	11.34	76.2	9.03	2.81	4.56	23.76	395.4	1.29

**Table 3.** Haematological parameters in owner dogs

TEST ORDINAL NUMBER	HCT (%)	HGB (g/dL)	MCHC (g/dL)	WBC (109/l)	GRANS (109/L)	%GRANS (%)	NEUT (109/L)	EOS (109/l)	L/M (109/l)	%L/M (%)	PLT (109/l)	Retic (%)
1	38.5	13.9	36.1	7.9	5.8	73	/	/	2.1	27	476	1.4
2	52.6	18.8	35.7	17.2	15.4	90	13.1	2.3	1.8	10	264	/
3	46.6	15.1	32.4	54.8	20.8	38	/	/	34.0	62	43	/
4	47.7	16.7	35.0	8.2	5.7	70	/	/	2.5	30	453	1.3
5	40.7	14.2	34.9	19.2	17.1	89	/	/	2.1	11	374	/
6	47.1	17.0	36.1	12.1	9.3	77	/	/	2.8	23	298	0.5
7	44.0	15.7	35.7	15.8	15.2	96	6.4	8.8	0.6	4	40	0.3
8	35.1	12.4	35.3	9.9	5.6	57	3.6	2.0	4.3	43	60	0.4
9	54.2	17.8	32.8	23.9	21.0	88	18.2	2.8	2.9	12	125	2.6
10	61.9	20.6	33.3	9.5	7.6	80	1.8	5.8	1.9	20	220	0.3
11	41.4	13.9	33.6	45.4	29.7	65	18.9	10.8	15.7	35	38	/
12	45.5	15.5	34.1	7.3	4.9	67	1.5	3.4	2.4	33	339	0.7
13	55.9	19.1	34.2	11.1	10.0	90	/	/	1.1	10	355	1.7
14	50.1	18.0	35.9	11.5	5.1	44	2.6	2.5	6.4	56	41	0.3
15	51.9	17.8	34.3	31.1	7.9	25	/		23.2	75	51	1.6
16	50.1	17.2	34.3	11.3	9.2	81	/	/	2.1	19	282	2.3
17	47.9	15.9	33.2	16.1	8.8	55	/	/	7.3	45	335	1.5
18	52.4	18.2	34.7	8.1	5.2	64	1.9	3.3	2.9	36	57	0.9
19	37.5	12.6	33.6	17.7	15.9	90	10.8	5.1	1.8	10	38	0.6
20	35.7	11.6	32.5	30.2	20.0	66	/	/	10.2	34	43	/
21	50.8	17.6	34.6	28.7	12.3	43	/	/	16.4	57	43	/
22	29.2	9.6	32.9	6.8	3.9	57	1.8	2.1	2.9	43	466	1.8
23	49.3	17.3	35.1	14.7	14.7	96	3.9	10.2	0.6	4	39	0.6
24	58.5	19.1	32.6	20.9	17.3	83	/	/	3.6	17	280	3.5
25	53.3	17.7	33.2	12.1	8.6	71	/	/	3.5	29	560	1.6
26	36.9	12.9	35.0	10.3	8.7	84	/	/	1.6	16	345	/
27	37.7	12.8	34.0	19.1	17.7	93	/	/	1.4	7	128	/
28	36.8	13.5	36.7	6.1	4.5	74	1.6	2.9	1.6	26	230	/
29	38.7	13.1	33.9	12.8	10.0	78	/	/	2.8	22	263	1.6
30	42.5	14.6	34.4	17.5	14.9	85	/	/	2.6	15	250	/
Mean value	45.68	15.67	34.33	17.24	11.76	72.3	6.62	4.76	5.50	27.70	217.86	1.27

The parameter highlighted in the study was related to eosinophils (Table 4).

**Table 4.** Comparison between eosinophils values obtained in dogs from shelters and owner dogs

ORDINAL NUMBER	PARAMETAR EOS (109/l)	
	DOGS FROM SHELTERS	OWNER DOGS
1	0.7	/
2	/	2.3
3	1.2	/
4	/	/
5	/	/
6	/	/
7	4.7	8.8
8	/	2.0
9	/	2.8
10	/	5.8
11	/	10.8
12	/	3.4
13	5.8	/
14	/	2.5
15	/	
16	/	/
17	2.2	/
18	/	3.3
19	/	5.1
20	4.6	/
21	/	/
22	2.6	2.1
23	/	10.2
24	3.0	/
25	/	/
26	2.4	/
27	1.5	/
28	/	2.9
29	/	/
30	2.3	/
<b>MEAN VALUE</b>	<b>2.81</b>	<b>4.76</b>

By analyzing the blood of dogs from the shelter and the blood of owner dogs. we found that there are several cases of eosinophilia in owner dogs.

The highest obtained value of eosinophils is  $10.8 \times 10^9/l$  and was determined in the dog under number 11 from the group of owner dogs. while the highest obtained value in the dog from the sheltered was under number 13 and is  $5.8 \times 10^9/l$ .

The lowest value obtained is  $0.7 \times 10^9/l$  and was determined in the dog under number 1 who is housed in asylum. In the case of the owner's dog, the lowest value of  $2.0 \times 10^9/l$  was recorded under ordinal number 8.

When we compared the mean values of this parameter, which in shelter dogs is  $2.8 \times 10^9/l$  and in owner dogs  $4.76 \times 10^9/l$ , it is clear that owner dogs not only have a larger number of individuals with eosinophilia but also a significantly higher value of this parameter which directly affects the health of the examined dogs.

The statistical data related to descriptive statistics for group A are shown in table 5.

**Table 5.** Statistical data of the analyzed parameters for groups A and B

Owner dogs	Age	Weight	HCT	HGB	MCHC	WBC	GRANS	GRANS_p	NEUT	EOS	LM	LM_pt	PLT	Retics
Valid N	30	30	30	30	30	30	30	30	13	13	30	30	30	20
Mean	6.62	18.57	45.68	15.67	34.34	17.24	11.76	72.30	6.62	4.77	5.50	27.70	217.87	1.28
Median	6.50	19.50	46.85	15.80	34.30	13.75	9.65	75.50	3.60	3.30	2.70	24.50	240.00	1.35
Minimum	0.50	3.00	29.20	9.60	32.40	6.10	3.90	25.00	1.50	2.00	0.60	4.00	38.00	0.30
Maximum	18.00	40.00	61.90	20.60	36.70	54.80	29.70	96.00	18.90	10.80	34.00	75.00	560.00	3.50
Lower	3.00	8.00	38.50	13.50	33.30	9.90	5.80	64.00	1.80	2.50	1.80	12.00	43.00	0.55
Upper	9.00	30.00	51.90	17.80	35.10	19.20	15.90	88.00	10.80	5.80	4.30	36.00	339.00	1.65
Variance	22.58	150.12	62.43	7.07	1.40	127.42	39.68	333.11	41.44	10.06	56.38	333.11	26025.02	0.75
Std.Dev.	4.75	12.25	7.90	2.66	1.18	11.29	6.30	18.25	6.44	3.17	7.51	18.25	161.32	0.86
Coef.Var.	71.82	65.99	17.30	16.96	3.44	65.46	53.56	25.24	97.19	66.51	136.44	65.89	74.05	67.80
Standard Err	0.87	2.24	1.44	0.49	0.22	2.06	1.15	3.33	1.79	0.88	1.37	3.33	29.45	0.19
Skewness	0.89	0.21	-0.02	-0.27	0.11	1.90	0.87	-0.86	1.12	1.11	2.63	0.86	0.35	0.90
Kurtosis	0.43	-1.42	-0.66	-0.64	-0.85	3.91	0.53	0.22	-0.23	-0.30	7.16	0.22	-1.03	0.74
Azil	Starost	Težina	HCT	HGB	MCHC	WBC	GRANS	GRANS_p	NEUT	EOS	LM	LM_pt	PLT	Retics
Valid N	30	30	30	30	30	30	30	30	11	11	30	30	30	26

Mean	4.27	16.63	43.28	14.42	33.28	15.89	11.34	76.20	9.04	2.82	4.55	23.77	395.40	1.30
Median	4.00	14.00	45.75	14.90	33.10	11.65	8.80	79.00	3.90	2.40	2.40	21.00	430.50	0.85
Minimum	1.00	3.00	30.20	10.30	29.40	5.90	4.70	45.00	1.70	0.70	1.00	10.00	45.00	0.20
Maximum	10.00	35.00	52.10	18.20	36.40	75.50	48.50	90.00	47.00	5.80	31.10	55.00	761.00	4.00
Lower	2.00	9.00	36.70	11.80	32.40	10.00	7.90	72.00	2.50	1.50	1.70	15.00	311.00	0.40
Upper	5.00	22.00	49.30	16.40	34.60	15.50	10.90	85.00	9.00	4.60	2.90	28.00	488.00	2.10
Variance	5.86	91.21	42.13	5.72	3.03	205.19	67.40	140.58	174.77	2.54	48.63	140.25	30211.28	1.32
Std.Dev.	2.42	9.55	6.49	2.39	1.74	14.32	8.21	11.86	13.22	1.59	6.97	11.84	173.81	1.15
Coef.Var.	56.72	57.42	15.00	16.59	5.23	90.13	72.39	15.56	146.30	56.50	153.15	49.83	43.96	88.71
Standard Err	0.44	1.74	1.19	0.44	0.32	2.62	1.50	2.16	3.99	0.48	1.27	2.16	31.73	0.23
Skewness	0.63	0.68	-0.42	-0.12	-0.38	3.42	3.56	-1.49	2.82	0.68	3.25	1.50	-0.23	1.05
Kurtosis	-0.33	-0.61	-1.19	-1.22	0.03	12.05	14.89	1.94	8.38	-0.40	10.17	1.98	0.56	0.06

In group A, which included dogs from the shelter, the number of observed individuals was 30 (table 5.). As it can be seen from the Table, the most interesting parameters are the minimum and maximum values.

In group B, which included owner dogs, the number of observed individuals was 30 (table 5.). As it can be seen in table 6., the most interesting parameters are the minimum and maximum values.

**Table 6.** Statistics for groups A and B

		N	Mean	Std. Deviation	Std. Error Mean
Age	Shelter dogs	30	4.27	2.420	.442
	Owner dogs	30	6.62	4.752	.868
Weight	Shelter dogs	30	16.63	9.550	1.744
	Owner dogs	30	18.57	12.252	2.237
HCT	Shelter dogs	30	43.280	6.4907	1.1850
	Owner dogs	30	45.683	7.9015	1.4426
HGB	Shelter dogs	30	14.417	2.3915	.4366
	Owner dogs	30	15.673	2.6584	.4853
MCHC	Shelter dogs	30	33.280	1.7399	.3177
	Owner dogs	30	34.337	1.1828	.2159
WBC	Shelter dogs	30	15.893	14.3246	2.6153

	Owner dogs	30	17.243	11.2879	2.0609
GRANS	Shelter dogs	30	11.340	8.2096	1.4989
	Owner dogs	30	11.760	6.2989	1.1500
GRANS_pr	Shelter dogs	30	76.20	11.857	2.165
	Owner dogs	30	72.30	18.251	3.332
NEUT	Shelter dogs	11	9.036	13.2200	3.9860
	Owner dogs	13	6.623	6.4372	1.7853
EOS	Shelter dogs	11	2.818	1.5924	.4801
	Owner dogs	13	4.769	3.1719	.8797
LM	Shelter dogs	30	4.553	6.9734	1.2732
	Owner dogs	30	5.503	7.5088	1.3709
LM_pr	Shelter dogs	30	23.77	11.843	2.162
	Owner dogs	30	27.70	18.251	3.332
PLT	Shelter dogs	30	395.40	173.814	31.734
	Owner dogs	30	217.87	161.323	29.453
Retics	Shelter dogs	26	1.296	1.1498	.2255
	Owner dogs	20	1.275	.8644	.1933

Table 7. Student –t test

	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Age	10.610	<u>.002</u>	-2.414	58	<u>.019</u>	-2.350	.974
Weight	5.826	<u>.019</u>	-.682	58	.498	-1.933	2.836
HCT	1.089	.301	-1.287	58	.203	-2.4033	1.8669
HGB	.446	.507	-1.925	58	.059	-1.2567	.6528
MCHC	3.578	.064	-2.751	58	<u>.008</u>	-1.0567	.3841
WBC	.007	.934	-.405	58	.687	-1.3500	3.3297
GRANS	.174	.678	-.222	58	.825	-.4200	1.8892
GRANS_pr	5.761	<u>.020</u>	.981	58	.330	3.900	3.974
NEUT	.866	.362	.583	22	.566	2.4133	4.1384
EOS	5.738	<u>.026</u>	-1.848	22	.078	-1.9510	1.0557

LM	.521	.473	-.508	58	<u>.614</u>	-.9500	1.8709
LM_pr	5.827	<u>.019</u>	-.990	58	.326	-3.933	3.972
PLT	.186	.668	4.100	58	<u>.000</u>	177.533	43.296
Retics	2.368	.131	.069	44	.946	.0212	.3082

The Student's t test is a test of significance. Between the mean values of the observed groups A and B (Table 7.) statistically significant differences were observed for the following observed variables: age ( $p=0.002$ ), weight ( $p=0.019$ ), granulocytes ( $p=0.020$ ), eosinophils ( $p=0.026$ ), lymphocytes ( $p=0.019$ ).

Other observed parameters were not statistically significant.

Kolmogorov-Smirnov test was used to compare the distribution between the groups.

**Table 8.** Comparison of distribution between groups using the Kolmogorov-Smirnov test

	Max Neg	Max Pos	p-value	Mean	Mean	Std.Dev.	Std.Dev.
Age	-0.3000	0.0333	$p > .10$	4.267	6.617	2.420	4.752
Weight	-0.2667	0.1667	$p > .10$	16.633	18.567	9.550	12.252
HCT	-0.2333	0.0333	$p > .10$	43.280	45.683	6.491	7.901
HGB	-0.2667	0.0333	$p > .10$	14.417	15.673	2.392	2.658
MCHC	-0.3333	0.0000	$p < .10$	33.280	34.337	1.740	1.183
WBC	-0.2333	0.0667	$p > .10$	15.893	17.243	14.325	11.288
GRANS	-0.2333	0.1667	$p > .10$	11.340	11.760	8.210	6.299
GRANS_pr	-0.2000	0.2333	$p > .10$	76.200	72.300	11.857	18.251
NEUT	-0.1259	0.2937	$p > .10$	9.036	6.623	13.220	6.437
EOS	-0.3287	0.0000	$p > .10$	2.818	4.769	1.592	3.172
LM	-0.2333	0.0667	$p > .10$	4.553	5.503	6.973	7.509
LM_pr	-0.2333	0.2000	$p > .10$	23.767	27.700	11.843	18.251
PLT	0.0000	0.5000	$p < .005$	395.400	217.867	173.814	161.323
Retics	-0.1654	0.1577	$p > .10$	1.296	1.275	1.150	0.864

Observing the analysis of the test (table 8.), the only recorded statistical significance was for the following parameter, namely PLT ( $p < .005$ ).

The Mann-WhitneyU-test (table 9.) is a nonparametric test that was used for uneven distribution between the two observed samples.

**Table 9.** Mann-Whitney U-test

	RankSum	RankSum	U	Z	P-value	Z	P-value	2*1sided
Age	793.50	1036.50	328.50	-1.789	0.074	-1.799	0.072	0.072
Weight	906.00	924.00	441.00	-0.126	0.900	-0.126	0.900	0.901
HCT	820.00	1010.00	355.00	-1.397	0.162	-1.397	0.162	0.164
HGB	787.00	1043.00	322.00	-1.885	0.059	-1.886	0.059	0.059
MCHC	748.00	1082.00	283.00	-2.462	0.014	-2.463	0.014	0.013
WBC	845.50	984.50	380.50	-1.020	0.308	-1.020	0.308	0.307
GRANS	885.00	945.00	420.00	-0.436	0.663	-0.436	0.663	0.665
GRANS_pr	952.00	878.00	413.00	0.540	0.589	0.540	0.589	0.592
NEUT	146.00	154.00	63.00	0.463	0.643	0.464	0.643	0.649
EOS	109.00	191.00	43.00	-1.622	0.105	-1.623	0.105	0.106
LM	863.50	966.50	398.50	-0.754	0.451	-0.755	0.450	0.449
LM_pr	877.50	952.50	412.50	-0.547	0.584	-0.547	0.584	0.582
PLT	1164.00	666.00	201.00	3.674	0.000	3.674	0.000	0.000
Retics	588.50	492.50	237.50	-0.487	0.626	-0.488	0.625	0.621

In this test the highest statistical significance was observed for MCHC (0.014), ( $Z=2.462$ ) and PLT ( $p=0.000$ ,  $Z=3.674$ ). Other observed parameters did not show statistical significance.

In the phylogenetic development of a parasite species, the transition from ordinary to parasitic life, as a the struggle for survival, led to adaptation to new living conditions, including morphological changes in body composition in relation to the state when the species lived freely in nature (Čanković and Jažić, 1998). We can freely assume that it was the case with our groups of examined dogs, which were, we can certainly say, infested with some of the parasite.

Also, endoparasites have adapted to anaerobic living conditions and perform intramolecular respiration by consuming glycogen (Čanković and Jažić, 1998), which essentially indicate on the great ability of endoparasites to adapt to different environmental conditions. Mentioned research is in line with our results, due to the importance of environmental factors, especially abiotic factors, on parasite infestation as well as on the hematological parameters in dogs.

In sensitive dogs, an allergic reaction to flea bites occurs, i.e. to proteins found in flea saliva. As a consequence of this allergy, these dogs have significantly more serious disorders and damage of hair and skin (Diba et al., 2004), which is not the case in our study, since no serious hair and skin damage was recorded in the examined groups of dogs.

If the tick's head remains in the dog's skin when the tick is removed, it should be monitored whether the residue will be spontaneously expelled in the following days. If the bite site turns red and signs of infection appear, the assistance of a veterinarian is needed (Diba et al., 2004), which is fully consistent with our study, especially when it comes to owner dogs, when owner brings a dog immediately after noticing the first symptoms to veterinarian, and the dogs from shelter were regularly subjected to medical treatment by the veterinary service.

Physical exertion or short-term excitement can lead to a transient increase in erythrocyte count, hemoglobin and hematocrit concentrations, and acute stress can lead to relative leukocytosis, neutrophilia, lymphopenia and eosinopenia (Trailović et al., 2000), which is partly the case in our study, where the occurrence of certain mentioned diseases has nothing to do with environmental factors or parasite infestation, and we can freely attribute them to the above factors. Measured values of erythrocytes, hemoglobin and hematocrit are closely related because they actually measure different aspects related to red blood cells. If the values of all three parameters are lower, than they indicate the existence of anemia, which is accompanied by symptoms of drowsiness and fatigue. Such blood disorders can also lead to anemia in dogs. Anemia can be caused by various factors, including low levels of certain vitamins or iron, chronic loss of a small amount of blood, or some other pathological processes in the body.

## CONCLUSIONS

After analyzing complete blood count using hemograms of 30 owner dogs and 30 dogs from shelter, that were kept in different conditions, and after statistical processing of the obtained data, as well as comparative analysis with available data from the literature, we came to the following conclusions:

Increased hematocrit and hemoglobin values in dogs from our study indicate that the subjects were without water for a long time or dehydrated, and possibly exposed to stress, which indicates that these dogs are exposed to adverse environmental factors. As mentioned, in November, the air temperature was elevated, which can also contribute to dehydration of dogs and lead to elevated hematocrit and hemoglobin values.

Dogs with increased white blood cell counts had mostly impaired health and potential inflammation, suggesting that increased white blood cell counts were not significant when it comes to parasite infestation and environmental factors. The percentage of granulocytes in the blood that was not within the normal values scale indicates that there is a possibility that the dogs were infected with parasites or bacteria, and this is important information when it comes to findings for a complete blood count.

Dogs that had an increased number of eosinophils also had a parasitic disease which is the most common case in infected dogs when it comes to hematological status.

Elevated values for platelets indicate potential bleeding or some of the problems with blood coagulation. Increased values for reticulocytes indicate the process of formation of young

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erythrocytes. This process is encouraged by iron-rich pills or foods given to the examined dogs.

The dogs that were under the constant supervision of a veterinarian were healthy. These are the dogs that stayed in the box of the Veterinary Station Tuzla.

A large number of owner dogs had parasitic diseases due to unprofessional handling with antiparasitics and less frequent visit to veterinarian. This was the case with dogs that stayed in the boxes and were exposed to unfavorable environmental factors.

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