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Prevalence of Blood Protozoa in Cattle in Babylon Governorate, Iraq

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THE aims of the current study were to determine the prevalence of blood protozoa in cattle in Babylon governorate, Iraq, through direct microscopic examination of blood smears, to study some of the hematological and biochemical changes, and to investigate some of the risk factors related to the disease. Blood samples were collected from 232 cattle of different ages from different parts of the Babylonian governorate and during different seasons. The overall prevalence of blood protozoa in cattle at Babylon governorate was 19.82% (46 out of 232). The prevalence of infection with *Babesia bigemina* was 7.75% (18 out of 232), *Theileria annulata* was 6.89% (16 out of 232), *Anaplasma marginale* was 5.17% (12 out of 232). There was a significant reduction in the levels of RBCs, hemoglobin, PCV, MCH, total platelet count, originator of fibrin, calcium, copper, iron, selenium, total protein, albumin, globulin, creatinine, and glucose in the infected animals with blood protozoa, while there was a significant elevation in the levels of ESR, AST, ALT, LDH, total bilirubin, and direct bilirubin in the infected animals with blood protozoa. The following are some of the risk factors related to a higher prevalence of blood protozoa : the older ages (3-7) years, exotic breeds, western and southern regions of the governorate, outdoor feeding, and the summer and spring seasons. In conclusion, the blood protozoa is prevalent in cattle in Babylon governorate and there are many risk factors linked to its prevalence.

Keywords: Blood protozoa, Cattle, Hematological changes, Biochemical changes.

Introduction

The tick-borne diseases have great attention of researchers worldwide due to their damaging effects on livestock production and their public health importance [1]. Among the tick-borne diseases, theileriosis, babesiosis, and anaplasmosis are the most important and worldwide distributed. These blood protozoa affect cattle in most parts of the world [2]. Two mainly Babesia spp., including *Babesia bigemina* and *Babesia bovis* are responsible for bovine babesiosis [3]. Four species of Theileria, including *Theileria sergenti*, *Theileria luwenshuni*, *Theileria annulata* and *Theileria sinensis* are the main etiological agents of bovine theileriosis all over the word [4,5]. While five Anaplasma spp. including *Anaplasma bovis*, *Anaplasma marginale*, *Anaplasma central*, *Anaplasma platys* and *Anaplasma phagocytophilum* are the main etiological agents of bovine anaplasmosis [6,7]. A large number of studies have reported the infection and prevalence of Theileria spp., Babesia spp. and Anaplasma spp. in cattle worldwide [8-10]. The perfect diagnosis of blood protozoa are very important for successful control measures. The Giemsa stained blood smears are the method of choice to detect blood protozoa in the blood of infected cattle especially in the acute stages of the disease [11,12]. The diagnosis of Theileria spp. are based on the light microscopic detection of the parasite in thin blood smears of the infected animals and presence of schizonts in stained lymph node biopsy smears. The Babesia spp. are a small protozoa found inside the cattle red blood cells [13]. The aims of the current study were to detect the prevalence of Theileria, Babesia and naplasma spp. in cattle in Babylon governorate, to

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study some of the hematological and biochemical changes associated with the infection, and to detect some of the risk factors related to the disease.

Material and Methods

Collection of Samples and Hematological examination

This study began with a period extending from March 2022 until February 2023. It included the examination of 232 cows with different ages ranging from <1 year to 7 years, the control group included 20 normal animals, while the infected groups comprised 46 animals that were naturally infected with common blood parasites, including *Anaplasma marginale* (12 animals), *Theileria annulata* (16 animals), and *Babesia bigemina* (18 animals). Blood samples were taken from the animals from the jugular vein after sterilizing the area where 10 ml from each animal were collected and divided into three sections, (2.5) ml of blood was placed in tubes containing EDTA as anticoagulants for conducting hematological tests such as the total number of red blood cells (RBCs), the concentration of hemoglobin (Hb), the packed cell volume (PCV), the mean corpuscular volume (MCV), the mean corpuscular hemoglobin concentration (MCHC), the total number of platelets, the mean platelets volume and its spread by using a digital blood cell counting machine)a company USA/Beckman Coulter(. The erythrocyte sedimentation rate (ESR) was calculated using a Wentrobe tube [14]. The clotting time was measured through using a special capillary tubes (with a bead) which were filled with blood after withdrawing it from the distal auricular vein, and the clotting time was calculated/min after stopping with the movement of the bead inside the capillary tube [15].

Also, 2.5 ml of blood were placed in tubes containing Trisodium anticoagulant citrate for the purpose of separating the blood plasma and using it to measure the origin of the fibrin, the time of the preceding two clots/sec and the activated partial thromboplastic time molecular/sec, using ready-made standard solutions (Kits) (Bio.TP/France) and according to the manufacturer's instructions. The blood smears stained with 10% Giemsa solution were used to detect the blood parasites [14].

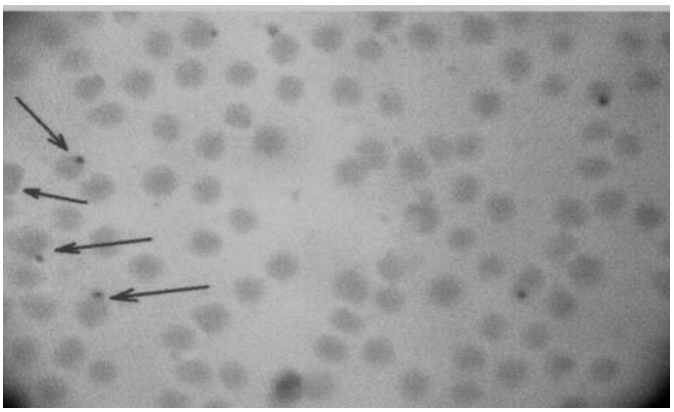

Figure 1.Microscopic examination of blood smears showed *Anaplasma marginalein* inside the RBCs, under oil immersion lens (100X).

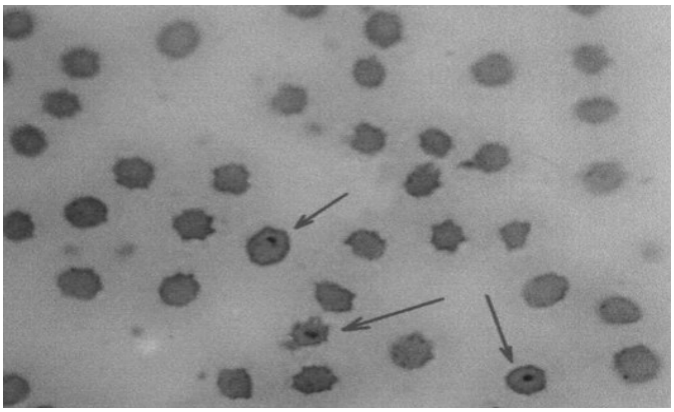

Figure 2. Microscopic examination of blood smears showed *Theileria annulata* inside the RBCs, under oil immersion lens (100X).

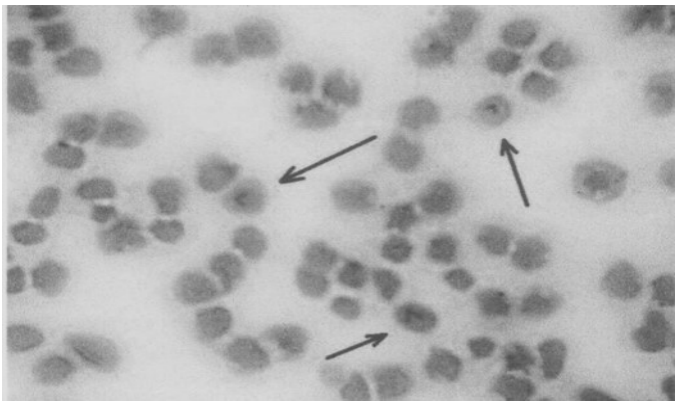

Figure 3.Microscopic examination of blood smears showed *Bobesia bigemina*inside the RBCs, under oil immersion lens (100X).

Biochemical examination

Five ml of blood was used to measure the biochemical parameters after the separation of the serum from the blood samples. calcium, copper, magnesium, Iron, and selenium had been calculated using a spectrophotometer using ready-made standard solutions (Bio.TP/France).The serum samples of the animals were used for biochemical parameters comprising globulin, albumin, total protein, creatinine, cholesterol, alanine aminotransferase (ALT), aspartate aminotransferase (AST), lactate dehydrogenase (LDH), glucose, direct bilirubin, and total bilirubin through using special cassettes for each test in a chemistry analyzer (IDEXX-Vet Test, Arachem, USA). The 40µL of serum samples were used and the procedure performed according to the chemistry guidebook.

Statistical Analysis

The results were analyzed statistically using IBM-SPSS statistics version 19, and the relative risk (RR) association with the prevalence blood protozoa was determined using Epi- Info TM7 software's 2 by 2 tables. All the significant differences were determined at ($P<0.05$).

Results

The prevalence of infection of cattle with blood protozoa in the current study was 19.82% (46 out of 232). The prevalence of infection with Babesia bigemina was 7.75% (18 out of 232), Theileria annulated was 6.89% (16 out of 232), and Anaplasma marginal was 5.17% (12 out of 232). The results of the study showed that infection with common blood parasites has a clear effect on the blood picture of the infected animals. There was a significant decrease ($P<0.05$) in the levels of the total number of red blood cells (RBCs), hemoglobin (Hb), packed cell volume (PCV) and mean corpuscular hemoglobin (MCH) in the infected cows with blood protozoa in comparison to the control levels, which resulted in the occurrence of anemia in different forms and according to the type of infection, while there was a significant increase in the levels of erythrocyte sedimentation rate (ESR) in the infected cows with blood parasites ($P<0.05$) in comparison to the cows of control group (Table 1). A discrepancy results were recorded in the levels of blood clotting factor values in animals infected with blood parasites. There was a significant decrease ($P<0.05$) in the levels of the total number of platelets in the infected groups of animals with *T. annulata* and *B. bigemina* in comparison with the animals of the control group and the animals that were infected with *A. marginale* group. Also a significant increase ($P<0.05$) in the platelet volume levels and the platelet proliferation rate in the infected group with *B. bigemina* in comparison to the animals of the control group and other study groups. There was a significant reduction in the fibrin origin rates in all infected groups of animals with blood protozoa in comparison to the control group. While a significant elevation in the clotting time and activated partial thromboplastin time were observed in *B. bigemina* infected groups in comparison to the control group and other study groups [Table 2]. In the present study there was a significant reduction in the levels of calcium, copper, Iron and selenium levels in the infected groups of animals with blood protozoa in comparison to their levels in the control group [Table 3].

TABLE 1.The hematological parameters in the infected animals with blood protozoa and control group.

Hematological parameters \ Treatments	Control group	*A. marginale*	*T. annulata*	*B. bigemina*
No. of animals	20	12	16	18
RBC × 10^6	7.201 ± 1.36^a	4.431 ± 0.70^b	4.622 ± 0.61^b	4.201 ± 0.44^b
H_b gm/100 ml	12.771 ± 1.62^a	6.812 ± 1.53^b	6.921 ± 1.73^b	5.981 ± 2.11^c
PCV %	33.952 ± 3.61^a	26.781 ± 2.53^b	27.364 ± 2.48^b	25.681± 3.74^b
MCV f/L	55.616 ± 2.31^a	53.223 ± 4.11^a	52.918 ± 5.61^a	63.412 ± 3.11^b
MCH Pico/gm	33.612 ± 2.14 ^{a}	26.641 ± 2.57^b	28.921 ± 1.33^b	27.615 ± 1.62^b
ESR	2.811 ± 1.44^a	12.641 ± 2.57 ^{b}	11.617 ± 4.72^b	14.628 ± 3.45^c

Values (Mean ± SE) bearing different alphabets in a row differ significantly (P<0.05).

TABLE 2.The differences in coagulation factor values in the infected animals with blood protozoaand control. group

Studied traits \ Treatments	Control group	*A. marginale*	*T. annulata*	*B. zbigemina*
No. of animals	20	12	16	18
The total platelet count × 10^3	408.231 ± 24.3^a	392.116 ± 22.5^a	280.214± 31.4^b	265.315± 22.11^b
Platelet volium in afemtoliter	8.719± 2.12^a	8.219±1.32^a	8.451±2.11^a	11.591± 3.14^b
Platelet proliferation rate %	16.242± 2.42^a	17.162± 3.21^a	16.213±2.54^a	19.214 ± 1.59^b
Originator of fibrin 100mg/ml	271.243± 28.1^a	250.413± 24.5^b	244.313± 21.3^b	211.391± 25.32^c
Clotting time /min.	3.311± 0.52^a	3.812± 1.23^a	3.712 ± 1.66^a	5.573± 1.20^b
Activated partial thromboplastin time/sec.	11.312± 2.16^a	12.615± 2.72^a	11.653± 2.21^a	19.225± 2.11^b
Movement time of two molecules/sec.	50.414± 3.27^a	52.617± 5.11^a	51.921± 3.45^a	62.116± 4.72^b

Values (Mean±SE) bearing different alphabets in a row differ significantly(P<0.05).

TABLE 3. Serum mineral levels in infected cattle with blood protozoa and control group .

Minerals \ Treatments	Control group	*A. marginale*	*T. annulata*	*B. bigemina*
No. of animals	18	16	12	20
Calcium (mg/dl)	11.89 ±1.22^a	10.69 ± 1.31^b	10.72 ± 1.36^b	8.2 ±1.53^b
Copper (mg/dl)	99.7 ± 6.22 ^{a}	53.12 ± 1.17^b	69.29 ± 1.14^b	59.96 ±1.45^b
Magnesium(mg/dl)	2.12 ± 0.074^a	1.62 ± 0.148^a	1.97 ± 0.23 ^{a}	1.55 ± 0.41^a
Iron (mg/dl)	110.22 ± 4.44^a	41.54 ± 8.20^b	53.38 ± 7.33^b	63.22 ± 8.41^b
Selenium (mg/dl)	91.78 ± 5.48 ^{a}	74.22 ± 3.1^b	61.33 ± 3.10 ^{b}	72.43 ± 3.12^b

Values (Mean±SE) bearing different alphabets in a row differ significantly (P<0.05).

In the current study there was a significant reduction in the levels of total protein, albumin, globulin, creatinine and glucose levels in the infected groups of animals with blood protozoa in comparison to their levels in the control group, while there was a significant elevation in the levels of AST, ALT, LDH, total bilirubin and direct bilirubin in the infected animals with blood protozoa in comparison to their levels in the control group (Table 4).The prevalence of blood protozoa in cattle in the current study was higher in the 3-7 years old group (41.86%) [Relative Risk (RR): 2.930 times, confidence interval(CI):1.640-5.233] than the 1-2 years and (<1 years) old group which were 29.03% and 14.28% respectively. In the present study the prevalence of blood protozoa in cattle was significantly higher in the exotic animals 42.37% [RR: 3.019 times,CI:1.829-4.981] than the native animals 14.00%. On the other hand, results showed no significant difference in the prevalence of blood protozoa between female and male animals. The prevalence of blood protozoa in cattle in was significantly greater in the southern, western

regions of Babylon Governorate which were 40.90% and 29.62% respectively (RR:2.812,2.037 times respectively,CI:1.392-5.681,0.951-4.360 respectively compared to the eastern and northern regions of Babylon Governorate which were 14.54% and 26.31% respectively (Table 5). The prevalence of blood protozoa in cattle in the present study was significantly higher in the outdoor feeding animals 42.37% [RR:3.019 times,CI:1.829-4.981] than the indoor feeding animals 14.03% [Table 5].Moreover, the prevalence of blood protozoa in cattle was significantly higher in the summer and spring seasons which were 44.92% and 35.93% respectively (RR: 4.133, 3.306 times respectively,CI:1.735-9.844,1.358-8.049 respectively) in comparison to the autumn and winter seasons which were 10.86% and 13.20% respectively [Table 5].

TABLE 4. Serum biochemical parameters in infected cattle with blood protozoa and control group.

Parameters \ Treatments	Control group	*A. marginale*	*T. annulata*	*B. bigemina*
No. of animals	18	16	12	20
Total protein gm/dl	7.934±1.22[a]	5.933±1.12[b]	5.623±1.21[b]	5.981±0.82[b]
Albumin gm/dl	3.341±0.41[a]	2.824±0.84[b]	2.925±0.46[b]	2.648 ± 0.22[b]
Globulin gm/dl	3.622± 0.25[a]	2.422±0.57[b]	2.612±0.33[b]	2.535 ± 0.42[b]
Creatinine mg/dl	2.66±0.037[a]	1.36±0.11[b]	1.67±0.10[b]	1.53±0.09[b]
AST U/L	58.42±2.36[a]	73.36±3.52[b]	71.52±2.63[b]	75.44± 2.11[b]
ALT U/L	21.52±1.21[a]	35.56±1.42[b]	33.26±2.11[b]	36.28±2.84[b]
LDH mg/dl	282.11±17.12[a]	340.13 ±14.33[b]	342.52 ±12.4 [b]	345.22±14.22[b]
Glucose mg/dl	78.64±3.21[a]	68.17± 2.52[b]	69.48± 3.22[b]	68.25±2.63[b]
Cholesterol mg/dl	158.62 ±7.37[a]	164.24 ± 6.14[a]	162.42±5.22[a]	163.44 ±3.72[a]
Total bilirubin mg/dl	0.68±0.25[a]	5.56±1.31[b]	4.36 ±1.11[b]	4.35±1.21[b]
Direct bilirubin mg/dl	0.04±0.05[a]	1.15±0.03[b]	1.25 ±0.06[b]	2.21±0.02[b]

Values (Mean±SE) bearing different alphabets in a row differ significantly(P<0.05).

TABLE 5. Some of the risk factors related to the infection of cattle with blood protozoa.

Risk factors \ Treatments	No. of dogs tested	No. of positive (%)	Relative Risk (RR)	Confidence Interval 95%(CI)	P-value
Age					
< 1 year	84	12(14.28)[a]	1		
1-2 years	62	18(29.03)[b]	2.032	1.058-3.902	0.029
3-7 years	86	36(41.86)[c]	2.930	1.640-5.233	0.00006
Breed					
Native breed	114	16(14.00)[a]	1		
Exotic breed	118	50(42.37)[b]	3.019	1.829-4.981	0.000001
Gender					
Male	112	34(28.33)[a]	1		
Female	120	32(28.57)[a]	0.878	0.584-1.321	0.533
Regions					
Easstern	55	8(14.54)[a]	1		
Northern	57	15(26.31)[a]	1.809	0.834-3.923	0.123
Western	54	16(29.62)[b]	2.037	0.951-4.360	0.057
Southern	66	27(40.90)[c]	2.812	1.392-5.681	0.0014
Type of feeding					
Indoor feeding	114	16(14.03)[a]	1		
Outdoor feeding	118	50(42.37)[b]	3.019	1.829-4.981	0.000001
Season					
Autumn	46	5(10.86)[a]	1		
Winter	53	7(13.20)[a]	1.215	0.413-3.569	0.722
Spring	64	23(35.93)[b]	3.306	1.358-8.049	0.0029
Summer	69	31(44.92)[c]	4.133	1.735-9.844	0.00011

Discussion

It was noted through the results of the study a considerable effect of blood protozoa on the blood picture of the infected animals with blood protozoa through the decrease in the levels of RBCs , Hb, PCV, MCH which in turn led to the occurrence of anemia in the infected animals, these results agreed with both Rosner *et al.* [16] and Alfonso *et al.* [17] where the researchers differed in determining the main causes of anemia in infection with blood parasites. Auerbach *et al.* [18] mentioned the cause of anemia may be due to the direct breakdown of red blood cells due to the multiplication of the parasites inside the red blood cells leading to hemolytic anemia. While others [19,20] believed that the auto-immunity has an important role in causing anemia, and this is confirmed by the presence of anti-erythrocyte antibodies, that are characterized by auto-agglutination. Also, the mechanism of cellular immunity in phagocytosis of infected red blood cells and their removal by phagocytes of the reticuloendothelial system, helps in decreasing total number of the red blood cells and causing anemia. Guimaraes *et al.* [21] mentioned that the fragility of the infected red blood cells leads to their break down easily. As well as, it was noted from the results of the study increase of erythrocyte sedimentation rate which are in agreement with Auerbach *et al.* [18], AL-Obaidi and Alsaad, [19]. While Weiss and Wardrop,[14] showed that the number of blood cells per volumetric unit affects erythrocyte sedimentation rate, so the speed of erythrocyte sedimentation increases whenever there is lower number of red blood cells. Any bleeding process occurs in the body due to the dissolution of red blood cells and other blood processes within the vessels. Blood clotting is followed by a process of coagulation, and there are basic factors that play an important role in the process of blood clotting, which are vascular factors characterized by a rapid response represented by narrowing and contraction of the vessel, causing a decrease in blood pumping which is directly related to integrity of blood vessels [22]. Furthermore, the numbers and activity of blood platelets have a significant and essential role in the clotting process, through which the aggregated platelets aggregates with each other and then stick together. Then they attach to the wall of the blood vessel, consisting of thrombus platelets or a plug temporary, and this stage is evaluated by calculating the total number of blood platelets and measuring their sizes and proliferation rate, as the increase in the platelet sizes and their increase in their proliferation rates indicates a decrease in their numbers [23,24], which is in agreement with the results of the current study and Collatos,[25] adds that the quantitative change in platelet numbers may also occur due to a decrease in their production in the bone marrow or because of the enlargement of the spleen with an increase in consumption of this type of cells due to damage of the lining of vessels [26], and this confirms the infection of cows with blood protozoa in which this type of platelet damage occurs, and the presence of the petechial hemorrhage on the infected animals is consider to be one of the reasons for the decrease in their numbers. The coagulation stage is one of the final stages of the clotting mechanism, which is characterized by enhancement of the activated factors like Hagman factor (X11),Plasma thromboplastin antecedent (X1) and component thromboplastin (1X) in a way of cascades, which primarily converts prothrombin to thrombin and converting the originator fibers into fibers. One of the results of this conversion is the deposition of fibrin clots within the blood vessels, in addition to calcium which plays a major role in this stage, especially in the process of shrinkage of these clots [27] and this may lead to decrease calcium levels in blood. The results of this study was agree with Pantanowitz, [26], Auerbach *et al.* [18] and Maxie *et al.* [28]. In addition, those who recorded clear differences in the criteria for the values of blood clotting factors in various diseases, including infection with blood parasites, where they indicated an increase in clotting time and activated partial thromboplastin time, which is defined as the measure of the extrinsic pathway for the coagulation process, and this time increases when the source of fibrin decreases and the liver's efficiency in producing it decreases, and others added [29] until the increase in the movement time of the two molecular clots, which is known as the intrinsic pathway for the coagulation process means its consumption in the coagulation mechanism or due to increase the level of vasoactive amines in the blood plasma, which is often observed in infections of the Babesia spp. or in poor production due to liver damage or when vitamin K deficiency occurs. Pantanowitz, [26] and Bick,[30] were agreed, that the difference in the standards of coagulation factor values, especially in animals infected with blood protozoa, may lead to a defect in the blood coagulation mechanism within the blood vessels and producing hemorrhagic diathesis, which causing a large and effective consumption of coagulation factor values, and forming fibrinous clots that deposited in the blood vessels [31].This may be a cause of diffuse vascular thrombosis, which resulted in a withered ischemia, especially in important organs such as the brain and lung, which are among the main or secondary causes of death for the affected animal [32].The current study observed there was a reduction in the levels of copper, iron and selenium levels in the infected animals with blood protozoa in comparison to the control group which may be attributed to the destruction of the red blood cells and anemia which associates the infection of the animals with blood

protozoa. Moreover, the current study showed that the glucose and hemoglobin levels were reduced significantly in the infected animals with blood protozoa in comparison to the control group, and this observation were similar to those reported by [33]. The reduction in blood glucose levels may be attributed to its utilization by the blood protozoa and liver damage in infected animals with blood protozoa. Serum ALT and AST levels are indicators of hepatic integrity. The elevation in the ALT levels in the infected animals with blood protozoa in comparison to the control group may be attributed to the alterations in the liver functions due to blood protozoa infections [34]. There was elevation in AST levels in the infected animals with blood protozoa in comparison to the control group and this finding is similar to the findings of Talkhan *et al.* [**35**].The elevation in AST and ALT levels in the infected animals in comparison to the control group might indicate hepatic dysfunction in blood protozoa infected animals. In investigation there was a significant elevation in the LDH levels in the infected animals with blood protozoa in comparison to the control group and this finding is similar to the findings of Talkhan *et al.* [**35**]. The LDH is a cytosolic enzyme which is present in the tissues which were involved in glycolysis, so the destruction process of these tissues leads to the liberation of LDH enzyme in to the extracellular fluids and other body fluids. So the detection of high levels of this enzyme which is liberated in to the blood stream from the damaged tissues represents a definitive diagnostic criterion for many diseases and disorders [36].The prevalence of infection of cattle with blood protozoa in the current study was 29.03% in 1-2 years age of cattle and this result was similar to the results of Fadly,[13] who reported that the prevalence of infection of cattle with blood protozoa was 28% in the 2-3 years age of cattle in Behera province, Egypt. While the prevalence of infection of cattle with blood protozoa in the current study was 41.86% in 3-7 years age of cattle and this result was higher than the results of Fadly,[13] who reported that the prevalence of infection of cattle with blood protozoa was 20% in the (>3 years) age of cattle in Behera province, Egypt.The prevalence of infection of cattle with blood protozoa in the current study was 14.28% in (<1 years) age of cattle and this result was lower than the results of (Simking et al. 37) who reported that the prevalence of infection of cattle with blood protozoa was 62.2% in the (<1years) age of cattle in Kanchanaburi province, Thailand. The prevalence of infection of cattle with blood protozoa in this study was 41.36% in the 3-7 years age of cattle and was similar to Weny *et al.* [38] who reported that the prevalence of infection of cattle with blood protozoa was 59.7% in the adult cattle and 40.3% in juveniles at the edges of Kibale national park, Western Uganda. The infection rate was low among young animals and this may be due to the young calves possess innate resistance enhanced by maternal antibodies, these resistance declined gradually leaving the animal with high susceptibility to the disease [39].The prevalence of blood protozoa infection in cattle in the present study was 42.37% in the exotic breeds and 14.00% in the native breeds and this result is similar to Weny *et al.* [38] who reported that the prevalence of infection of cattle with blood protozoa was 60.2% in exotic breeds and 39.8% in the indigenous breeds so the prevalence of infection was higher in the both studies in the exotic breeds than the local breeds. The prevalence of blood protozoa infection in cattle was 28.33% in males and 28.57% in females without significant differences between the both sexes and this result is incompatible with Simking *et al.* [37] who reported that the prevalence of infection in females was 48.5% which is significantly higher than the males 37.5%..The prevalence of blood protozoa was significantly higher in the western and southern regions of Babylon governorate and this finding is compatible with the results of Zhou *et al.* [8] who reported different prevalence of blood protozoa in the different parts of Chongqing, China and this may be attributed to the high populations of the vectors in the western and southern regions of Babylon governorate in comparison to the eastern and northern regions of the governorate. The high density of cattle rearing in the western and southern parts also plays an important role in the elevation of the prevalence of blood protozoa in the western and southern regions of the governorate in comparison to the eastern and northern regions of the governorate. Likewise, the results of the present study was similar to the results of Simking *et al.* [**37**] who reported different prevalence of blood protozoa in the different parts of Kanchanaburi province. Thailand due to differences in the high populations of the vectors between different parts of the province. In the present study the prevalence of blood protozoa was significantly higher in the outdoor feeding animals than the indoor feeding animals which may be attributed to the more contact of the outdoor feeding animals to the vectors such as ticks during grazing, while the indoor feeding animals don't have much contacts with the vectors due to using the insect repellents in the cattle barns **[40].**The seasonal incidence of the blood protozoa in the current study revealed that the maximal infection rate was recorded during summer months followed by spring. These results agreed with that obtained by Garcia *et al.* [**41**] in large animals. The prevalence of infection of cattle with blood protozoa in the present study was significantly higher in the spring and summer seasons in comparison to autumn and winter seasons and this result is compatible with the results of Fadly, [13] who reported that the

prevalence of Babesia Spp. in cattle was 28%, 23% in summer and spring seasons respectively at Behera province, Egypt while in autumn and winter seasons were 12% and 8% respectively. Furthermore, Fadly, [13] was reported that the prevalence of Theileria Spp. in cattle was 30%,28% in summer and spring seasons respectively at Behera province, Egypt while during autumn and winter seasons were 16% and 12% respectively. The variation in the infection rates in different seasons may be attributed to the effect of climatic conditions on the tick activity which increased in summer and spring seasons.The variation in incidence rates of infection with blood protozoa could be explained by the climatic condition of the area of the study that enhances the life cycle of ticks and gives higher chance to ticks infest animals and subsequently increasing the prevalence of blood parasites **[42]**.Also, variation may be due to the immunological status of animals and different ages, different breeds and sexes.

Conclusion

The blood protozoa are prevalent in cattle at Babylon Governorate including *Anaplasma marginale*, *Theileria annulata* and *Babesia bigemina* and there are many risk factors linked to their prevalence.

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Conflicts of interest

The authors declared that no conflicts of interest.

Author`s contributions

Alyaa S.K. Al-Shammari : Sample collection,Blood tests,Preparing tables and drawing figures. Mozhir K.K. Almahdawi ; Writing review,writing—original draft,methodology,Statistical analysis of data and Abdulsattar S.S.Al-Bayat; investigation,Visualization Follow up on the health status of animals.

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انتشار طفيليات الدم في الأبقار في محافظة بابل، العراق

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ان اهداف الدراسة الحالية هو تحديد نسبة انتشار أوالي الدم في الأبقـــار في محـــافظة بابل / العراق خلال الفحـــص المجهري المباشر لمسحات الدم ، ودراسة بعض التغيرات الدموية والكيموحيوية وللتحري عن بعض عوامل الخطورة المتعلقة بهذا المرض . تم جمع عينات الدم من ٢٣٢ بقرة ذات أعمار مختلفـــة ومن مناطق مختلفة من محـــافظة بابل وخلال مواسم مختلفة . وكانت نسبة الانتشـــار الكلي لأوالي الدم في الأبقار في محـــافظة بابـــل ١٩,٨٢% (٤٦ حالة اصابة من مجموع ٢٣٢) وكانت نسـبة الاصـــابة بالبابيزيا بايجمينا ٧,٧٥% (١٨ حالة اصـــابة من مجموع ٢٣٢) والثايليريا أنيولاتا ٦,٨٩% (١٦ حالة اصـابة من مجموع ٢٣٢) والأنابلازما مارجينيل ٥,١٧% (١٢ حالة اصابة من مجموع ٢٣٢) . وكان هناك انخفاضا معنويا في مستويات أعداد كريات الدم الحمر ، تركيز خضاب الدم ، حجم كريات الدم المرصوصة ، معدل هيموكلوبين الكرية ، العـــدد الكلي للأقراص الدمـــوية ، ومنشأ الفبرين والكالسيوم والنحاس والحديد والسلينيوم والبروتين الكلي والألبومين والكلوبيولين والكرياتنين والكلوكوز في الحيوانات المصابة بأوالي الدم بينما كان هناك ارتفاعا معنويا في مستويات سرعة ترسب كريات الدم الحمر ، وأنزيم الأسبارتيت ناقـلة الأمين وأنزيم الألنين نافلة الأمين وأنزيم اللاكتيك منزوعة الهيدروجين والبيليروبين الكلي والبيليروبين المباشر في الحيوانات المصابة بأوالي الـدم . وفيما يلي بعض عوامل الخطورة المتعلقة بزيادة انتشـــار أوالي الدم : الأعمار الأكبـــر (٣-٧) سنوات ، السلالات المستوردة ، المناطق الغربية والجنوبية من محافظة بابـــل ، والتغذية خارج الحضائر ، وخلال مواسم الصيف والربيع . نستنتج من هذه الدراسة بأن أوالي الدم منتشرة في الأبقـــار في محافظة بابل وهناك عدة عوامل خطورة تتعلق بزيادة انتشار المرض .

الكلمات المفتاحية : أوالي الدم ، الأبقار ، التغيرات الدموية ، التغيرات الكيموحيوية ، محافظة بابل.