

Some of Biochemical Tests for Blood Serum and Some of Hematological Variants of the Blood for Iraqi Camels Infected with Blood Parasites

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ABSTRACT

This study was conducted to measure some biochemical tests of blood serum and some hematological variables of Iraqi camels infected with blood parasites. We collected randomly (70) blood samples for the period of time from the beginning of 1/6/2018 to 30/6/2019 with an age ranging (less than one year - 14 years) (For both sexes), (20) samples of which, with a percentage (28.57%) from camels who were in good health condition for approval as a control group to compare the results of their chemical and blood tests with the results of the tests for camels infected with blood parasites, and a number (50) samples, at a rate (71.43%) from camels, who was suffering from anemia, pall and yellowish of the mucous membranes, combined with areas of edema in the neck, chest, genitals and limbs. The first work of the study is to do clinical examination of all the animals used for research then make blood smears, and biochemical tests of blood plasma was performed, then a statistical analysis of the results obtained was performed using the (SPSS) program. The results of the research showed that number (14) at (28%), had *babesia*, number (15) at 30%, had *anaplasma* while (9) at (18%) had *trypanosoma*, and number (12) at 24%, had *thalaria*. The results of the clinical examination, after comparing them with the control group, showed there was a statistically significant difference at a level of ($p < 0.05$) between healthy and infected camels. As for the results of the blood tests, it was noted there was a decrease in the values of the tests for the blood samples of animals infected with blood parasites than in the animals of the control group, thus, a statistically significant difference at a level of ($p < 0.05$) was recorded between the two groups, but there was no statistically significant difference at a level of ($p < 0.05$) between animals that infected with blood parasites between them. The results for the values of MCV, MCH, and MCHC, we found that they did not show any statistically significant difference at a level of ($p < 0.05$) between the control group and the group of infected animals also between the infected animals between them. The results of the total number of white blood cells and the differential count for each type of leukocytes in the control and infected group showed a significant statistical difference at a level of ($p < 0.05$) between the two groups and between the types of leukocytes between them and the results of the biochemical tests, the presence of a statistically significant difference at a level of ($p < 0.05$) between the control group and the infected camel group.

Keywords: Biochemical test, Blood parasites group, Blood serum, Control group, Hematological variants, Iraqi camels.

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INTRODUCTION

Camels represent an important national wealth, as they are part of the livestock in the Arab world and Iraq.¹ They are a treasure of the desert treasures that God Almighty has given to mankind. It is a versatile animal that has been used in the transportation, production of milk, meat and dander since ancient times.²

The number of camels in the world is currently about (20) million heads, of which 14 million are in the Arab region, which is equal to (70%) of the world's camels. Africa occupies the first place includes (75%) of the world's camels, followed by Asia with (25%). Of the Arab countries famous for camel

breeding, Somalia comes first (54%), followed by Sudan (26%), Mauritania (7.3%), then Libya, Tunisia, Saudi Arabia, Egypt, Algeria and the UAE. As for Iraq, the number of camels has decreased in the last two decades to less than (10) thousand heads, after it was estimated at more than (50) thousand heads in the seventies. Among the non-Arab countries in which there are distinct numbers of camels: India, Pakistan, Mongolia, Ethiopia and Kenya.²

Camels have unique characteristics that are unparalleled in other animals that enable them to adapt to conditions of thirst or drought in hot climates where they lose 30% of body fluids or about 40% of their live weight, and yet they remain alive

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as for humans and other animals, losing 10% of body fluids It often leads to perdition or death ⁽³⁾. Camels can benefit from metabolic water liberated from the decomposition of the fat of the hump in a way that man cannot match, as the fat burns and generates energy that the animal benefits to continue its vital activity also liberates carbon dioxide, which the animal gets rid of by exhalation and the water is generated, this is why the hump is consumed by the thirsty and hungry camels tends to the side to become an empty sack if hunger and thirst prolonged.^{3,4}

Research has proven the ability of camels to resist animal diseases, however it is possible to infected by many camels of diseases, external, internal parasites, and blood parasites.^{5,6} These diseases affect animal health also may cause several illnesses and possibly death. Camels medicine has a long history in the world and in Iraq.⁷⁻⁹ Camel blood parasites are transmitted through vectors such as hard ticks and a number of types of blood stinging flies such as *Tabanus* and *Stomoxys liberosia* and *Haematobia* that transmit blood parasites.¹⁰⁻¹² Among the blood parasites that infect camels are *Trypanosomes evansi*, *Anaplasma*, *Thaleria*, and *Babesia*, these diseases cause great economic losses in the world and Iraq due to the lack of programs that control, prevent blood diseases and parasites in a large way, especially since some of these diseases are not available for vaccines.¹³⁻¹⁶

Blood is one of the important tissues of the animal due to the dynamism that it is characterized by virtue of its continuous and organized movement, it is sensitive to the changes occurring in the various cells and tissues of the body, that studying these changes can be an accurate indicator of the health or physiological state of the animal.^{5,7} Blood constitutes about 7% of the body weight of a camel, as is the case in other animals, it is generally a viscous and dense liquid, with a bright red color due to the presence of hemoglobin in the red blood cells.^{17,18} The blood tends to be slightly alkaline, where the pH is within the limits of 7.35, the blood consists of:

- Blood serum (Plasma), which is the fluid in which blood cells swim, it contains all clotting factors, proteins such as albumin also the blood serum transports the digested food to all parts of the body, and carries food waste to the kidneys, lungs to excrete it outside the body.
- Blood cells, which include red, white blood cells and platelets.¹⁹

Despite the importance of camels, they did not find enough interest in them compared to other mammals, there is insufficient research available for them, especially on blood diseases, parasites, their functions, and in terms of studying the biochemical blood, the elements it contains that help camels with stand difficult environmental conditions, from hot heat in the day and cold at night, scarcity of water and pasture²⁰⁻²² as a result, we were selected for this topic of our research.

The aim of the study is to measure some biochemical tests of blood serum and some blood variables of camels infected with blood parasites to compare them with normal rates in healthy camels to note the extent of changes in these tests when infected with blood parasites.

MATERIALS AND WORK METHODS

Research Design

Collect randomly, 70 blood samples from camels brought for treatment at the veterinary clinic in the province of Najaf, from camels that graze in the natural pastures of the Western Badia in the city of Najaf and Najaf Sea for the period of time from the beginning of 1/6/2018 to 30/6/2019, their ages Between (less than 1 to 14 years) of males and females, of which, 20 samples from who had a very good health condition, as they were examined clinically and in a laboratory to ensure that they were free of internal, external parasites and blood parasites, their skin was intact from wounds, abrasions and their dander shiny for approval as a control group to comparing the results of the biochemical tests and blood tests of their with the results of the tests for camels infested with blood parasites, while the remaining number (50) samples were collected from an camels who was suffering from anemia, pallor and yellowish of the mucous membranes. Clinically and in vitro, we confirmed that they were infected with blood parasites (trypanosome, babesiosis, anaplasmosis and thaleria). All the research animals were divided into five groups starting with the first group (1≤ -2) years to ending with the group (12–14) years, as shown in Table 1.

Clinical Examination and Clinical Signs

At the first we done clinical examination was conducted after the animal was seated by tying one of its front limbs to allow it to sit and then tying its head well so that the head and neck were bent towards the far side from the examiner and tied to the

Table 1: The numbers and ages of healthy camels and camels infected with blood parasites from which blood samples were collected.

Age / year	Numbers of infected camels with B.P	Percentage %	Numbers of healthy (control)	Percentage %	Summation	Percentage %
(1≤ -2) years	11	15.714	5	7.142	16	22.857
(3–5) years	14	20	4	5.714	18	25.714
(6–8) years	10	14.285	5	7.142	15	21.43
(9–11) years	8	11.428	3	4.285	11	15.714
(12–14) years	7	10	3	4.285	10	14.285
Summation	50	71.43	20	28.57	70	100

Abbreviation: B.P: Blood parasite

hind leg of the animal itself then used the clinical examination techniques,¹⁸ that include Examination of the mucous membranes of the conjunctiva of the animal's eye, measuring the temperature, the movement of the rumen, measuring the speed of pulse and breathing, and noting the clinical signs of each animal (infected and intact) which a blood sample was collected, also examined skin and dander if it is shiny or not to ensure the presence or absence of external parasites and the safety from injury or abrasions.

Blood Samples Collection

We collected (70) samples of blood from the jugular vein of the animal by measuring 10 mL injection and a measuring needle (G22) to withdraw 5 mL of blood volume after sterilizing the site by wiping it with ethyl alcohol. Then a portion of the blood (0.5–1) mL is poured into a plastic tube containing an anticoagulant (EDTA), a di-potassium salt of ethylene amine tri-acetic acid at a concentration of (1–2) mg/mL, then closed the vial and moved precisely and quietly in the form of a number (8) Several times to dissolve the anticoagulant and mix it well with the blood.¹⁹ The remaining part of the blood up to 4 mL, placed in sterile, clean plastic tubes specially without anticoagulant, which are closed well and put it aside in order to allow the blood to clot.¹⁹

After collecting the samples, put the tubes of the blood in containers containing ice grits and transported quickly to the laboratory of the veterinary dispensary in the governorate of Najaf in the case of collecting samples from the Badia and Al-Najaf Sea. The first working step is to place the bottles of clotted blood in a centrifuge (10,000) rpm for a period 3–5) for the serum to be separated, then it is withdrawn quietly by special sterile plastic droppers (single use), and placed in other clean and sterile bottles and frozen and kept until all samples are collected to do biochemical tests on them.^{19,23} We measured : Total protein (g/dL), Albumin (g/dL), Globulin (g/dL), B-Urea (mg/dL), B-Sugar (mg/dL), Creatinine (mg/dL), AST (U/L), ALT (U/L), Iron - Fe ($\mu\text{g/dL}$), (Copper -Cu $\mu\text{g/dL}$), Calcium (mg / dl, Potassium (mmol / L), Magnesium (mmol/L)),

The portion of blood containing an anticoagulant is used to perform a total blood test that includes the red blood cells count (RBCs), white blood cell count (WBCs), hemoglobin (Hb), packed cell volume (PCV), mean corpuscular volume (MCV), Mean corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin concentration (MCHC). Also we

made blood smears and stained them with Leishman stain to make a differential count of white blood cells according to the method.¹⁹

Making Blood Smears and Microscopically Tests

This done by taking a drop of blood and placing it on the slide and then withdrawing it with a second slide to make blood smear then stained it by Leishman stain.¹⁰ Then the slides are examined with a light microscope under the oil immersion lens to observe the blood parasites and confirm the infection with blood parasites, as well as to make a differential count of white blood cells.²⁴

5-Statistical Analysis

The results analyzed statistically, where the data results of healthy camels compared with the results of the data of infected camels using statistical analysis in the program (SPSS) for windows operating system (version 16).²⁵ The results were expressed as \pm standard error and the statistical significant difference was adopted by an amount ($p < 0.05$).

RESULTS AND DISCUSSION

The results of the research showed for samples collected from (70) animals from camels of both sexes. Clinical and laboratory examination was carried out for it, so (20) animals by (28.57%) were in good health, free from external a, internal and blood parasites, also without any external wounds and shiny dander, they were approved as a control group to compare the results of their blood and biochemical tests with hematological and biochemical tests of infested camels with blood parasites, and, as for the number of (50) other animals by (71.43%), they were infected with blood parasites. These animals had a clinical signs of general weakness, thinness, pallor of the mucous membranes as a result of anemia, tearing of the eyes, secretions from the nose, in addition to recording some cases of repeated miscarriage and enlargement lymph nodes, edema in the lower jaw and posterior legs, it was confirmed that these animals were infected with blood parasites by making blood smears for them and dyeing them with Leichmann stain, so it was found that the number of (14) by (28%) infected with babesiosis, (15) by (30%) infected with anaplasmosis, (9) by (18%) Infected with trypanosomiasis and (12), (24%) infected with thaleraia, as shown in Table 2.

Table 2 shows the numbers, types and percentages of blood parasites in camels infected with blood parasites. It also shows that the highest number and percentage of infection was the

Table 2: Number of blood samples of camels, camels infected with blood parasites, numbers and types of blood parasites according to their age.

Age / year	Numbers of infected camels with B.P	Babesia	%	Theileria	%	Trypanosoma	%	Anaplasma	%
(1 \leq 2) years	11	2	4	2	4	2	4	3	6
(3–5) years	14	3	6	2	4	1	2	3	6
(6–8) years	10	3	6	3	6	3	6	4	8
(9–11) years	8	4	8	2	4	1	2	3	6
(12–14) years	7	2	4	3	6	2	4	2	4
Summation	50	14	28	12	24	9	18	15	30

infection with the Anaplasma parasite while the lowest number and rate of infection was the trypanosomiasis parasites.

The results of the clinical examination of healthy camels or (control group) as shown in Table 3. Temperature ranged from the (35.90 ± 0.2°C–36.59 ± 0.28°C), respiratory rate (9.07 ± 1.22–13.10 ± 1.5) (cycle/min), pulse rate (37.59 ± 2.27 - 43.58 ± 2.34) (beat/min), and the rumen movement was (3.97 ± 1.08 - 4.54 ± 0.98) (movement / 2 min).²⁶

Table 3 explains the results of the clinical examination of healthy camels, which are considered as a control group, showing the highest and lowest number recorded for temperature, respiratory rate, pulse rate and ruminal movement.

The results of the clinical examination of camels infected with blood parasites, as shown in Table 4, the temperature was recorded as (36.52 ± 0.26°C)–(37.3 ± 0.36°C), respiratory rate (11.9 ± 1.6–17 ± 2.8) (cycle/min), pulse velocity (44.72 ± 1.7 - 64.42 ± 2.36) (beat/min) and the rumen movement was (1.00 ± 0.30–2.00 ± 0.59) (movement / 2min).²⁶

Table 4 Explains the results of the clinical examination of camels infected with blood parasites, showing the highest and lowest number recorded for temperature, respiratory rate, pulse rate and ruminal movement.

After studying the results in tables (1,2) and comparing them with each other, we notice an increase in the average values of body temperature, pulse rate and respiration rate in camels infected with blood parasites than in control group camels due to the presence of the parasite in the peripheral blood or as a result of the presence of secondary bacterial infection.^{18,27} Thus, a statistically significant difference is recorded at a level (p <0.05) between healthy camels and infected camels with blood parasites while the ruminal movement, the average values shown a decrease in the affected camels than in the control group, this is may be the reason for slowing the movement of the rumen as a result of digestive disorders that lead to stagnation of the rumen,^{18,27} this records a statistically significant difference at (p <0.05).

As for the results of the blood tests of the control group and the infected camels for the average values of the number of red blood cells, hemoglobin, and the packed cell volume, respectively, as shown in Table 5. RBCs (8.62 ± 1.8, 3.15 ± 0.01) (10⁶ /μL), Hb (11.7 ± 0.8, 6.7 ± 0.01) (g/dL), PCV (28.1 ± 2.9, 19 ± 0.01) (%), when studying these values we note there was a decrease in the values of the animals infected with blood parasites than in the animals of the control group, thus a statistically significant difference was recorded at a level of (p <0.05) between the two groups but there was no statistically significant difference with a level of (p > 0.05) between the animals infected with blood parasites themselves.

The reason for the decrease in packed cell volume (PCV) in infected camels with blood parasites, especially those infected with trypanosomiasis is the fragility of the red blood cells.²⁸ The cause may also be attributed to the devouring of the red blood cells as a result of the adhesion of antigens released by the parasite as indicated by other researchers,²⁹ while the decrease in hemoglobin and packed cell volume (PCV) together due to nutritional reasons as a result of infection with parasites so it is cause lack of appetite for food then lead to anemia.^{30,31} As for the values of MCV, MCH and MCHC for the control group and infected camels shown in Table 5, respectively:

MCV (60.31 ± 0.01, 58.8 ± 0.31) (fl), MCH (15.6 ± 2.2, 20.6 ± 0.3) (pg),

MCHC (40.6 ± 2.1, 39.3 ± 0.01) (%). We studying these values statistically found that there was no statistically significant difference at a level of (p > 0.05) between the control group and the group of infected animals, also between the infected animals among themselves.^{30,31} Table 5 also shows the total number of white blood cells and the differential count for each type of white blood cells in the control and infected group, respectively:

WBCs (12.95 ± 0.45, 18.95 ± 0.98) (103/μL), Neutrophil (57.80 ± 0.72, 66.13 ± 1.39) (%), Lymphocyte (35.85 ± 0.75, 25.13 ± 1.63) (%), Monocyte (4.55 ± 0.15, 5.25 ± 0.31) (%), Eosinophil

Table 3: Types and results of the clinical examination of healthy camels (control group)

Age / year	Numbers of healthy (control)	Body temperature (°C)	Respiratory rate (cycle/min)	Pulse rare (beat/min)	Ruminal movement (movement/2min)
1 ≤ year– 2 years	5	36.03 ± 1.33	10.15 ± 0.53	38.85 ± 0.93	4.30 ± 0.14
3 – 5 years	4	35.90 ± 0.2	10.85 ± 0.6	39.75 ± 0.93	3.97 ± 1.08
6 – 8 years	5	35.99 ± 0.09	9.07 ± 1.22	37.59 ± 2.27	4.54 ± 0.98
9–11 years	3	36.46 ± 0.24	11.55 ± 1.25	43.58 ± 2.34	4.25 ± 0.16
12 – 14 years	3	36.59 ± 0.28	13.10 ± 1.5	41.53 ± 1.94	4.28 ± 0.13

Table 4: Types and results of the clinical examination of camels infected with blood parasites

Age / year	Numbers of infected camels	Body temperature (°C)	Respiratory rate (cycle/min)	Pulse rare (beat/min)	Ruminal motility (movement/2min)
1 ≤ year- 2 years	11	37.3 ± 0.36	14.5 ± 1.32	64.42 ± 2.36	1.00 ± 0.30
3–5 years	14	36.52 ± 0.26	11.9 ± 1.6	44.72 ± 1.7	2.00 ± 0.59
6–8 years	10	37.1 ± 0.85	17 ± 2.8	49.25 ± 3.8	1.00 ± 0.30
9–11 years	8	37.12 ± 0.22	14.09 ± 1.09	52.75 ± 2.94	1.00 ± 0.30
12–14 years	7	36.8 ± 0.55	13.93 ± 1.58	47.18 ± 2.39	2.00 ± 0.59

(1.65 ± 0.15, 3.5 ± 0.37) (%), Basophil (0.15 ± 0.08, 0.0 ± 0.0) (%). After studying the above results and analyzing them statistically, we found an increase in the total number of white blood cells and differential count for each type of white blood cells except for lymphocytes between the control group and the group of infected camels, from these results there was a statistical significant difference with a level of (p < 0.05) between the two groups of animals and between the types of white blood cells among themselves, the reason here is due to the secondary bacterial infection or as a result of the emotion and fear the animal generates when it is pulled and seated to conduct clinical examination and drawn the blood.^{32,33} The results of the statistical analysis of the number of lymphocytes showed that there was no statistically significant difference at the level of (p > 0.05) between the infected camels and the control group, because the main function of the lymphocytes is their immune activity, after exposure to antigens, they abound and also in the case of chronic diseases or inefficiency of the adrenal cortex.^{30,34} The results recorded an increase in the number of acid leukocytes in the infected camel group than in the control group, this explains the result of allergic reactions to foreign proteins in the case of infection with internal parasites such as intestinal worms and blood parasites that lead to eosinophilia,³¹ thus there is a statistical difference significant at a level of (p < 0.05) between the infected camel group and the control group.

Table 5 shows the number of red blood cells and the number of leukocytes in the camels of the control group and the camels infected with blood parasites. The table shows that there is a statistically significant difference at a level (p < 0.05) between the blood tests in the two groups.

The results of the biochemical tests shown in Table 6 After studying and analyzing them statistically, they showed a statistically significant difference at a level (p < 0.05) between the control group and the infected camel group in the results of measuring Iron, Copper, Calcium, Potassium and Magnesium in control and infected camels, respectively:

Table 5: Examination of some hematological variants of healthy camels and camels infected with blood parasites

<i>Variables of blood</i>	<i>Healthy camels M ± SE</i>	<i>Infected camels M ± SE</i>	<i>p-value</i>
RBCs (10 ⁶ /μL)	8.62 ± 1.8	3.15 ± 0.01	p < 0.05
Hb (g/dL)	11.7 ± 0.8	6.7 ± 0.01	
PCV (%)	28.1 ± 2.9	19 ± 0.01	
MCV (fi)	60.31 ± 0.01	58.8 ± 0.31	
MCH (pg)	15.6 ± 2.2	20.6 ± 0.3	
MCHC (%)	40.6 ± 2.1	39.3 ± 0.01	p < 0.05
WBCs (10 ³ /μL)	12.95 ± 0.45	18.95 ± 0.98	
Neutrophil (%)	57.80 ± 0.72	66.13 ± 1.39	p > 0.05
Lymphocyte (%)	35.85 ± 0.75	25.13 ± 1.63	
Monocyte (%)	4.55 ± 0.15	5.25 ± 0.31	p < 0.05
Eosinophil (%)	1.65 ± 0.15	3.5 ± 0.37	
Basophil (%)	0.15 ± 0.08	0.0 ± 0.0	

Iron - Fe (114.5 ± 1.6, 91.96 ± 3.62) (μg/dL)
Copper -Cu (75.88 ± 9.22, 103.58 ± 16) (μg/dL),
Magnesium (mmol/L) (2.19 ± 0.58, 1.54 ± 0.03),
Potassium (mmol/L) (5.32 ± 0.93, 3.96 ± 1.02) and
Calcium(mg/dL) (9.46 ± 1.5, 6.52 ± 0.88),

From these results, we notice a decrease in the average value of iron and copper in the affected camels than in the control camels, the reason here is considered as a defense mechanism in the body that prevents the introduction of iron into the cells,^{35,36} also in the trypanosomiasis disease, which causes anemia that leads to a disorder related to the iron balance, and the cause of anemia is most likely due to a lack of dietary iron or due to an imbalance in the use of iron stores in the body caused by copper deficiency, that is, the lack of attachment to iron. It is caused by a deficiency of copper in the body, either because of its lack of food or because of poisoning by toxic plants that interfere with copper metabolism in the body.³⁷ Also, hemolysis due to parasite infection, especially trypanosomiasis, leads to magnesium deficiency due to severe erythrocyte degeneration.³⁸

Potassium deficiency in infected camels due to nutritional deficiency as a result of the lack of appetite of the animal due to anemia,³⁹ while calcium deficiency in affected camels compared to animals of the control group, it is related to protein deficiency when we note table 6, we will also notice a decrease in the value of total protein, albumin and globulin, as a result of infection with blood parasites, which leads to anemia, lack of appetite, and then insufficient food intake.^{39,40}

The biochemical tests of blood serum of the research animals recorded the results of the total protein and albumin examination in Table 6 a statistically significant difference at a level (p < 0.05), and there was no statistical difference (p > 0.05) for globulin between infected and healthy camels.

Table 6: Some biochemical tests for healthy camels and camels infected with blood parasites

<i>Biochemical values</i>	<i>Healthy camels M ± SE</i>	<i>Infected camels M ± SE</i>	<i>p-value</i>
Tp (g/dL)	8.55 ± 1.009	11.25 ± 0.18	(p < 0.05)
A (g/dL)	4.45 ± 0.04	6.23 ± 0.12	
G (g/dL)	3.92 ± 0.12	3.9 ± 0.11	(p > 0.05)
B-urea (mg/dL)	32.84 ± 5.79	44.34 ± 3.97	
B- sugar(mg/dL)	72.5 ± 8.75	50.37 ± 2.96	
Creatinine (mg/dL)	1.3 ± 0.49	2.49 ± 0.05	
AST (SGOT) (U/L)	35.92 ± 4.17	62.78 ± 1.29	
ALT (SGPT) (U/L)	12.48 ± 3.56	22.98 ± 2.63	(p < 0.05)
Fe (μg/dL)	114.5 ± 1.6	91.96 ± 3.62	
CU (μg/dL)	103.58 ± 16	75.88 ± 9.22	
Ca (mg/dL)	9.46 ± 1.5	6.52 ± 0.88	
K (mmol/L)	5.32 ± 0.93	3.96 ± 1.02	
Mg (mmol/L)	2.19 ± 0.58	1.54 ± 0.03	(p > 0.05)

Abbreviation : Tp/ Total protein, A/ Albumin, G/ Globulin, B-urea/ Blood urea, B- Sugar/Blood suger, AST / Aspartate,aminotransferase,, ALT/ Alanine aminotransferase, Fe/ Iron, Cu/ Copper, Ca/ Calcium, K/ Potassium, Mg/Magnesium

In this study, albumin, globulin, and total protein ratios were associated with low concentrations of calcium, iron and copper in affected camels. This may indicate its role in reducing the immune response in affected camels, as well as the increase in total protein in infected camels compared to healthy camels, the reason may be due to an increase in immune proteins, and that the decomposition of blood cells that accompanies infection with trypanosomiasis also this will lead to the release of blood proteins and increase the protein content.⁴¹ As for the high levels of urea and creatinine in the serum of infected camels, which reached, respectively (44.34 ± 3.97 mg/dL, 2.49 ± 0.05 mg/dL), compared with animals in control group respectively (32.84 ± 5.79 mg/dL, 1.3 ± 0.49 mg/dL), The reason may be due to renal deficiency caused by parasite infection leading to glomerulonephritis.⁴¹ As for the low blood sugar level of infected camels, which amounted to 50.37 ± 2.96 mg/dL compared to healthy camels, which amounted to (72.5 ± 8.75) mg/dL, This is due to nutritional reasons because the affected animals suffer from a lack of appetite and refrain from grazing, thus causing low sugar (hypoglycemia).^{42,43} The results for AST and ALT in infected camels, respectively (62.78 ± 1.29) (U/L), (22.98 ± 2.63) (U/L), the results were high, compared to their values in healthy camels, which were respectively (35.92 ± 4.17) (U/L), (12.48 ± 3.56) (U/L), these results are roughly consistent with the results recorded in other researches.^{30,44} The reason for these high results for liver enzymes may be due to the risk of oxidative stress due to parasite infection and degeneration in liver cells due to lack of oxygen.^{44,45}

Table 6 shows the measurement of some biochemical tests for healthy camels and camels infected with blood parasites, showing the measurement of Total protein, Albumin, Globulin, blood urea, blood sugar, Aspartate, aminotransferase, Alanine aminotransferase, Iron, Copper, Calcium, Potassium, Magnesium.

RECOMMENDATIONS

- Following scientific methods that lead to developing livestock production and raising the country's economic level.
- Conducting a phylogenetic study to detect various camel blood parasites in Iraq; being extremely sensitive in its identification the strain of the parasite, to which strain it belongs, and the degree of similarity with the strain of the other world, this helps to determine the type of medicine that can be used against these parasites.
- Production of vaccines and the use of preventive medicines as treatments to prevent the spread of blood parasites.
- Conducting new research studies to find out whether camel blood parasites have the potential to be transmitted to humans.
- Conducting a study to discover the effects of blood parasite diseases on humans because owners and farmers are in contact with the animal.

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