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Effect of Lice and Tick Infestation on Some Immunological Parameters in Sheep and Goats

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Abstract: Four species of ticks, Hyalomma sp., were collected from sheep and goats. , Boophilus, Rhipicephalus and a new species recorded for the first time in Salah al-Din Governorate / Iraq, which is the genus *Amblyomma*.

The results showed that by examining 810 heads of sheep of both sexes, the number of sheep that were infected with blood parasites (*Theileria, Babesia,* and *Anaplasma*) reached 385 infected sheep, with the highest infection recorded for *Theileria* by 6%, followed by *Babesia* by 5.4%. As for *Anaplasma*, it was recorded The lowest percentage is 3.52%. As for goats, 330 heads of both sexes were examined, and the number of infected goats was 158 heads, and infections of *Babesia* were recorded at a rate of 9.16%, while *Theileria* recorded a lower infection rate of (5.1%), while no infections were recorded in *Anaplasma*.

The results of the current study showed the effect of parasites on the blood picture. The results of the study showed that there was a significant increase ($P \leq 0.01$) in the rate of eosinophil white blood cells in the case of infection with *Theileria*, *Babesia* and *Anaplasma* parasites.

The results of the study showed that there were significant differences in the level of IgG antibody in male sheep and goats infected with lice, ticks and blood parasites, as the ratio was 2.917 ± 0.907 and 3.39 ± 1.60, respectively. No significant differences were recorded in female sheep and goats in the level of IgG antibody, as the rate was 2.90 ± 0.45 and 3.35 ± 1.07 in infected females.

Significant differences were recorded in males and females of infected sheep and goats in the INFγ level, which amounted to 155.5 ± 9.19 and 187.5 ± 19.4 in males, and in females it was 121.5 ± 21.4 and 186.7 ± 23 .5.

The results showed that there were no significant differences between male and female sheep when measuring the level of interleukin 17 (IL-17), it was 40.01 ± 5.70 and 41.9 ± 7.00, respectively. While significant differences were recorded in infected male and female goats, reaching 145.0 ± 16.1 and 136.0 ± 15.8, respectively.

As for interleukin 12 (IL-12), significant differences were recorded in infected female sheep and infected male and female goats, while no significant differences were recorded in infected male sheep, as it reached 154.8 ± 16.9 in sheep and 361.0 ± 27.8 and 216.3 ± 216.3 in goats. 24.2. While it was 140.20 ± 7.60 for male sheep.

Significant differences appeared in infected males and females of sheep in the level of IL-6, where values were recorded as 83.7 ± 7.8 and 41.5 ± 6.6, and significant differences were also recorded in infected female goats, which were 83.8 ± 18.2, while no significant differences were recorded in male goats. infected, where it was 99.3 ± 10.1.

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Introduction: Parasites cause widespread diseases among livestock, as they have a severe negative impact on their health, and internal and external parasites cause losses of up to about 40% of animal production (Bush and Clayton, 2018). External parasites (ticks, lice, myiasis) It is a common parasite on livestock (farm animals), because of which many countries whose economy depends on livestock lose money (FAO, 2020).

Tick ticks are small to medium sized hematotrophic ectoparasites, which are classified within the phylum Arthropoda, (Bigya *et al*., 2018). And ticks transmit many diseases to humans and animals alike, which directly affects animals from a veterinary and economic point of view because it transmits many bloody protozoa that lead to a deterioration in the health of the animal and a decrease in the level of productivity (Capinera, 2020).

As for lice, it is a small insect without wings that lives as a parasite on the host, and it has a distinctive characteristic, which is the characteristic of specialization for the host, and it is an important carrier of many diseases that affect humans and animals together, and infecting sheep and goats with lice leads to their destruction if not addressed. Treatment, in addition to the fact that it transmits many diseases, including louse-borne relapsing fever and trench fever (Dnrden, 2019).

Among the diseases transmitted by ticks, the presence of Theileria was noticed for the first time by the researcher Robert Kock in red blood cells, and it was in various forms, including bacillus, oval and round, and it was believed at first that it was miniature forms belonging to the Babesia parasite, and until that time, Theileria had not been known or have been described (Kumar *et al*., 2018).

Babesia is a tick-borne disease that affects a wide range of farm animals, including sheep and goats. It is caused by a single-celled parasite that lives inside red blood cells of the genus Babesia (Smith *et al*., 2021).

Anaplasmosis is a fairly widespread parasitic disease that can cause significant damage to animal health and rarely lead to livestock mortality. However, it is difficult and associated with significant financial costs as well as a significant time period, Its clear clinical symptoms include a sharp increase in body temperature, heavy and intermittent breathing resulting from oxygen deprivation and rapid pulse, lethargy, indifference in behavior, miscarriage during pregnancy and severe anemia, and failure to treat it leads to the death of the animal (Radostitis, 2022).

As for the immunological study and the study of cytokines, which play an important role in mediating inflammatory processes launched by specialized cells, which have proven effective in very low concentrations, where there are two categories of cytokines, the first are pre-inflammatory such as IL-6 and tumor necrosis factor tumor necrosis factor and other anti-inflammatory cytokines such as IL-4, IL-10, IL-13 (Arafasm, 2020), and IL-10, which is known to be immunosuppressive, and IL-6, which works to stimulate immune markers during co-infection (Gou *et al*., 2020).

Cytokines are regulated glycoproteins or polypeptides that are found outside the cell, where they carry out the process of transferring information or instructions and communication between cells. They have a molecular weight of (60000-6000) Daltons (Oppenheeim and Ruscetii, 2020). The independent activation of T cells is less complex than the activation of B cells, which depends on T cells, as they are more complex, but despite the complexity, the immune response is much stronger

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and works to develop memory and has a major role in various immune processes. And the release of these kinetics (cytokines) leads to the activation and production of immune cells, which may result in the release of large numbers of cytokines (Ouyang and O Garra, 2019).

Interferon-gamma (INF-ɣ) is a glycoprotein with a molecular weight of 17-25 kDa that has been called a type II interferon and is also known as a macrophage activating factor (MAF) (Moaif *et al.* , 2017). And that this interferon is produced and stimulated by highly active Th1 cells and CD8 cells and also produced by NK cells and cytotoxic T cells, in addition to that it can be produced by IL-12 and IL-18 (Scgroder *et al*., 2022).).

IL-6 is a multi-acting, helical cytokinesis with a molecular weight of 22-28 kDa that is a precursor to inflammation and can be encoded by a gene called interleukin-6 (IL-6). This interleukin is secreted by macrophages as a result of a response. Pathogen Associated Molecular Patterns (PAMPS) of microbial molecules are called Pathogen Associated Molecular Patterns (PAMPS) (Heinrich *et al* ., 1990).

Interleukin-12 (IL-12) is an interleukin naturally produced by macrophages, neutrophils, and B lymphoblasts (Zhou *et al.*, 2019). IL-12 belongs to the interleukin-12 family and this family is unique in that it is composed of the only heterologous cytokines, which include IL-12, IL-23, IL-27, and IL-35. Although they share many structural features and molecular similarities, they are They mediate various functional effects (Zhang and Kaplan, 2020).

IL-12 plays an important role in the activities of natural killer cells and T lymphocytes. IL-12 mediates the enhancement of cytotoxic activity. There also appears to be a link between IL-2 and IL-12 signal transduction in NK cells.IL-12 stimulates the expression of two IL-12 receptor. IL-12 also has anti-angiogenic activity, which means that it can prevent the formation of new blood vessels, and it does this by increasing the production of gamma-interferon, which in turn increases the production of a chemical called inducible protein (Uzrail *et al*., 2019).

The aim of the study is to know the effect of infection with some ectoparasites on some immunological parameters in sheep and goats.

Materials and methods:

1- Field study: A field survey was conducted on infected and uninfected sheep and goats from the beginning of August 2021 until the end of July 2022. During this period, 1,617 animals for each of sheep and goats were examined in 6 main areas for breeding these animals in the city of Tikrit, which are Al-Alam, Al-Bu Ajeel, Erbidah, Samra, Al-Khuzama and Tal. Sibat. The visit was according to the availability of the numbers of animals, and it may reach an average of 2-3 visits per week. Most of the places from which samples were taken were attached to old mud houses, and most of them had floors covered with animal waste with the availability of grass and fodder. Write down all the information in a special form.

2- Laboratory tests

2-1: ticks

1-1-2: Collect tick samples from sheep and goats: Tick samples were collected from infected animals (sheep and goats) manually and through the use of cotton moistened with alcohol at a

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concentration of 70% after placing it on the area containing ticks, in order to avoid breaking the parts of the tick in order to facilitate the process of classifying it, because this substance works to relax the muscles of the mouth. They are removed from the body of the infected animal with a small tweezer with a wide end, and then placed inside plastic bottles containing 70% ethyl alcohol, taking into account that they are closed directly. Full information was recorded on this box (the date of collection, the location of the tick on the animal's body, and the area where plural, gender, age) (Soulsby, 1986).

2-1-1-2: ticks classification: The process of diagnosing ticks was based on the morphological and biological characteristics adopted by (Hoogstral *et al.*, 1981 ; Estrada-pena *et al*., 2004). The diagnosis was made using a compound light microscope and a dissecting microscope. The most important characteristics that were relied upon in the classification is the shape of the base of the head, Basis capitulum. And the presence or absence of Festoons and the locations and shape of the spiracles, as well as the legs, the size of the tick and the external shape. The diagnosis was made in the Parasitological Research Laboratory in the College of Veterinary Medicine / University of Mosul, and the classification was documented in the Museum of Natural History / University of Baghdad.

2-2: Lice

1-2-2: Collecting lice samples from sheep and goats: Lice samples were collected from animals by hand, keeping in mind that the animal was calm, and alcohol was used if the removal process was difficult to preserve parts of the sample. It was placed in plastic tubes containing 70% ethyl alcohol, and all information about the animal (sex, place of collection, date) was recorded. , location on the body) in a special form for information and samples were diagnosed in the Museum of Natural History / University of Baghdad.

2-2-1-2: Collecting blood samples: Blood samples were collected from all animals infected with ticks and lice and were not infected, so 1617 blood samples were collected from the areas included in the study and from both sexes and their ages ranged from one month to four years. After that, it is placed on the glass slide and then spread with another slide, then dried and fixed with absolute methyl alcohol 70% for a period of (2-5) minutes, after which it was dyed with Giemsa stain for a period of (15-18) minutes, and then it was examined under a microscope using a 100x oil lens. .

3- Immuno Tests: The ELISA technique (Enzyme linked immune sorbent assy) was used in these tests to estimate the levels of cytokines in the serum of samples for the study, as follows:

3-1: Estimation of cytokinesis 6 (IL-6) levels.

3-2: Estimation of cytokinesis 12 (IL-12) levels.

3-3: Estimation of cytokinesis 17 (IL-17) levels.

3-4: Estimation of interferon INFγ.

3-5: General principle of specific tests

The equipped company, Sunlong, used the ELISA technique in the laboratory, in vitro, and is used for quantitative measurement in serum, plasma, and other biological fluids. In this technique,

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antibodies specific for each type are used, where standard solutions and samples (sera) are placed in small holes, and fixation is done with antibodies in a plate Discrimination, then the small vessels are washed with a washing solution and a solution of the diluted Biotinyiated antibody is added to them, and after washing the plate to remove the unbound Biotinyiated antibody, then the conjugated streptavidin-HRP enzyme is added to each hole and then washed again, and then the reagent solution (TMP) is added. For each hole, a blue color will be formed, and the color will be according to the ratio of interleukins and other specific tests, after which a stop solution is added, and the color will change from blue to yellow. The optical density is measured using the ELISA reader at a wavelength of 450 nm.

method:

1- Dilute the standard solution for immunological tests IL-6, IL-12, IL-17, IgG, IFN - ɣ provided with the personal kit by performing a series of 5 dilutions as indicated by the Chinese manufacturer sunlong of origin for the ELISA technology.

2- Put 40 microns of the solution in each hole.

3- 10 microns of the sample to be tested was added to each hole and then mixed well with continuous shaking quietly.

4- Incubation: Incubation took place for 30 minutes in the incubator at 37 degrees after wrapping the plate with special adhesive tape.

5- Dilution of the concentrated washing solution: 30 ml (30x) of the concentrated washing solution was diluted with distilled water to prepare 600 ml of the buffer washing solution.

6- The washing process: remove the tape

6- The washing process: remove the sticky tape carefully, after that the washing process takes place automatically and the washing process is repeated 5 times.

7- Put 50 microns of Horseradish peroxidase (HRP) - conjugate in each hole.

8- The plate was closed with adhesive, then incubated as shown in step 3, and the washing process was repeated with distilled water as shown in step 6.

9- Color: 50 µl of chromatin A solution was added with 50 µm of chromatin B in each hole with the reverse gear for the purpose of mixing.

10- It was incubated for 15 minutes at a temperature of 37 while avoiding light while adding color.

11- 50 microns of the stop solution was added to all the pits where the color changed from blue to yellow.

12- The absorption result was read for the macroscopic density of all pits at the wavelength of 450 nm, where the results were read within 10-15 minutes of adding the reaction stop solution and based on the macroscopic density according to the linear regression equation of the standard curve.

4- statistical analysis: The results were analyzed statistically by applying the Minitab statistical program by choosing analysis of variance (ANOVA) and the chi-square test, and the arithmetic

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means were compared with the (Duncan) multinomial test with a probability level of $p \leq 0.05$ and $p \leq 0.01$.

Results and Discussion: 433 ticks were collected from sheep belonging to 4 genera of ticks, *Hyalomma* sp. , *Boophilus*, *Rhipicephalus* and a new species recorded for the first time in Salah Al-Din Governorate, which is the genus *Amblyomma*, as shown in Table (1). In the current study, 125, 75 females and 75 males, respectively, were infected with ticks belonging to *Hyalomma* sp. With a percentage of 200%, 78 and 43 females and males, respectively, of *Boophilus*, with a percentage of 121%, 35, 23 females and males of *Rhipicephalus*, with a percentage of 58%, and 37, 17 females and males, respectively, with a percentage of *Amblyomma*, with a percentage of 54%.

A total of 197 goat ticks belonging to four genera of ticks were collected, and 50, 20 females and males, respectively, belonging to *Hyalomma* sp. 35%, 40, 24 females and males of *Boophilus* at a rate of 32%, 22, 12 females and 12 males of *Rhipicephalus* at a rate of 19%, and 18, 8 females and males of *Amblyomma* at a rate of 13%.

The results of the current study showed the presence of four species of hard ticks on sheep and goats, namely *Hyalomma*, which includes *Hyalomma anatulicum anatulicum*, *Boophilus*, which includes *Boophilus annulatus*, *Rhipicephalus*, which includes *Rhipicephalus sanguineous*, and *Amblyomma*, represented by *Amblyomma* spp. And the percentage of its presence on sheep increased by 12%, and on goats by 13%, *Hyalomma* recorded the highest rates of prevalence in sheep and goats by 46% and 35%, respectively. Hiding by finding suitable places for him until the return of suitable conditions for him to resume his activity. And these results that were reached in the current study are similar to many researchers in Iraq, which show the presence of hard ticks on many hosts, including sheep and goats, but with different rates in terms of prevalence and presence.

The results showed that by examining 810 heads of sheep of both sexes, the number of sheep that were infected with blood parasites (*Theileria, Babesia*, and *Anaplasma*) reached 385 infected sheep, with the highest infection recorded for *Theileria* by 6%, followed by *Babesia* by 5.4%. As for *Anaplasma*, it was recorded The lowest percentage is 3.52%. As for goats, 330 heads of both sexes were examined, and the number of infected goats was 158 heads. Infections of Babesia were recorded at a rate of 9.16%. As for *Theileria*, it recorded a lower infection rate of (5.1%), while no infections were recorded in *Anaplasma*, Table (2).

The results of the current study showed the effect of parasites on the blood picture. The results of the study showed that there was a significant increase ($P \leq 0.01$) in the rate of acidic white blood cells compared with healthy sheep in the case of infection with *Theileria, Babesia* and *Anaplasma*. The results showed that there was a significant increase ($P \leq 0.05$) in the rate of neutrophil blood cells in sheep, compared with healthy ones, with a clear difference of (6.32), while healthy ones reached (5.05), as well as for other parasites. The results showed a significant increase ($P \leq 0.05$) in the rate of lymphocytes in the case of infection with *Theileria* parasite. respectively in infected animals, corresponding to (3.85 a) in healthy animals. The results showed that the infection of mononuclear blood cells (monocytes) was equal at a significant level ($P \leq 0.05$) in case of infection with *Theileria*, as it reached (325.0 a) in infected animals, while it reached the same rate in healthy animals. While the results showed a significant decrease ($P \leq 0.05$) in the case of infection with *Babesia* and *Anaplasma* parasites, which reached (285.5 c) and (306.2 a) respectively, while the healthy ones reached (325.0 a).

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The results showed that there was a significant increase ($P \leq 0.01$) in the rate of eosinophilic white blood cells in the case of infection with *Theileria* and *Babesia*, where the infection rates were (8.3 a), (9.6 a), respectively, while the healthy goats recorded (4.2 b). While a significant decrease was recorded at the same level in the rate of single white blood cells (monocytes). It was also observed that there was a significant increase at a significant level ($P\leq 0.05$) in the rate of neutrophil white blood cells in the case of infection with *Theileria* and *Babesia*, where infection rates were (46.1a), (45.7a), respectively. While a significant decrease was recorded at a significant level ($P\leq 0.05$) in the rate of lymphocytes in white blood cells in the case of infection with *Theileria* and *Babesia*, where the infection rates were (47.55 a), (45.25 b), respectively, and the healthy one recorded (48.15 a). And that these results, which recorded a significant increase at a significant level ($P\leq 0.05$) in the average of mononuclear and eosinophilic white blood cells in goats and sheep, were identical to the findings of(Ismael and Samarai, 2019), and differed with (Haron *et al*., 2014; Salem and El-Sherif, 2015) indicated that there was a significant increase followed by a decrease in the total number of white cells with the progression of the disease due to the influence of cytokines. And the results recorded a significant decrease at a significant level ($P \leq 0.05$) in the percentage of lymphocytes in sheep and goats, as this decrease occurs as a result of the depletion of lymphocytes in the immune response (Morrison, 2015). While the results differed with (Valli, 2007), who indicated that the increase in the number of white cells is due to the increase in lymphocytes as a defense response of the body against infection with blood parasites. As mentioned by (Bishop ,2004), these changes may be due to toxic metabolic residues of the parasite affecting the blood-forming organs, especially the white blood cells. While Haron *et al*., (2014) showed that these differences in the features of leukocytes may be attributed to different stages of infection in different studies, where in the stage of acute infection there is a response in increasing leukocytes and then it gradually decreases when the disease becomes chronic and sustainable.

The results of the study showed that there were significant differences in the level of IgG antibody in male sheep and goats infected with lice, ticks and blood parasites, as the ratio was 2.917 ± 0.907 and 3.39 ± 1.60, respectively, compared to the control group, which was 4.500 ± 1.28 and 3.92 ± 1.44, respectively. No significant differences were recorded in female sheep and goats in the level of IgG antibody, as the rate was 2.90 ± 0.45 and 3.35 ± 1.07 in infected females, compared to the control group, which was 3.92 ± 1.44 and 3.83 ± 0.74, respectively (table4).

Significant differences were recorded in males and females of infected sheep and goats in the INFγ level, which amounted to 155.5 ± 9.19 and 187.5 ± 19.4 in males compared to the control group 11.52 ± 10.4 and 135.6 ± 17.4, respectively, and in females it was 121.5 ± 21.4 and 186.7 ± 23 5. Compared to a group The control was 258.0 ± 26.0 and 139.8 ± 24.3, respectively, as shown in (Table 4).

This nomenclature agrees (Athanasiou *et al*., 2021; Athanasiou *et al*., 2023) in their recording of IgG antibody in 318 sheep previously infected with ticks *Bovvelia burgdofen*, which was accompanied by a decrease in the number of white blood cells, especially lymphocytes, and with a lower number of 162 sheep. They have a recent tick infection through IgM antibody diagnosis.

(Omer *et al*., 2002; Haron *et al*., 2014; Salem and El - Sherif, 2015) indicated an increase in the effect of cytokines after a decrease in the total number of white cells with the progression of the disease, an indication of the immune response. The main cytokine in the immune response under study is INF-γ, which showed a significant increase compared with control groups in infected males

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and females of sheep and goats. Functional in both types of natural and specific immunity, as it increases the activity of both granulocytes and macrophages (Romo *et al*., 2016).

The results showed that there were no significant differences between male and female sheep when measuring the level of interleukin 17 (IL-17), it was 40.01 ± 5.70 and 41.9 ± 7.00, respectively, compared with the control group, which amounted to 47.10 ± 6.10 and 40.20 ± 8.00, respectively. While significant differences were recorded in infected males and female goats, reaching 145.0 ± 16.1 and 136.0 ± 15.8, respectively, compared with the control group of 69.9 ± 11.9 and 38.9 ± 6.23, respectively, as shown in Table (5).

As for interleukin 12 (IL-12), significant differences were recorded in infected female sheep and infected male and female goats, while no significant differences were recorded in infected male sheep, as it reached 154.8 ± 16.9 in sheep and 361.0 ± 27.8 and 216.3 ± 216.3 in goats. 24.2 compared to the control group, 196.2 ± 20.1, 202.3 ± 25.7, and 174.5 ± 21.8, respectively. While it was 140.20 ± 7.60 ± 7.60 in male sheep, compared with 144.22 ± 7.15 in the control group, as shown in Table (5).

Significant differences appeared in infected males and females of sheep in the level of IL-6, where the values were recorded as 83.7 ± 7.8 and 41.5 ± 6.6, compared with the control group 47.0 ± 7.1 and 34.0 ± 5.9, and significant differences were also recorded in infected female goats, which were 83.8 ± 18.2 compared to the control group 47.9 ± 9.4, while no significant differences were recorded in infected male goats as it was 99.3 ± 10.1 compared to the control group 92.4 ± 15.0 as shown in Table (5).

The emergence of a significant difference between male and female infected goats compared with the control group in terms of an increase in the level of interleukin 17 (I L-17), an indication that the type of infection is of the old type (chronic) and in turn stimulates neutrophils and monocytes and directs them to the area where antigens are present. (Martin *et al*., 2013).

The results of the statistical analysis showed an increase in the level of cytokine type I L-12, which is secreted by activated macrophages and thus stimulates the production of INF-γ. Its formation is stimulated by active macrophages and natural killer cells, which differentiate into Th1 helper cells (Zheng *et al*., 2016).

And the high level of interleukin-6 (IL-6) in the serum of infected males and females of sheep and infected female goats, is an indication of their emergence from T cells and macrophages resulting from the initiation of the immune response against parasitic infection, where they begin to secrete interleukin-6 (IL-6).) and tumor necrosis factor (INFγ) in the first infection, where it acts as an anti-inflammatory cytoxin (Toshio *et al*., 2014).

Table (1): Percentage of tick species present on sheep and goats

species	Number on sheep	Percentage	Number on goats	Percentage
Hyalomma sp.	200	46	70	35
Boophilus sp.	121	28	64	32
Rhipicephalus	58	13	37	19

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Amblyomma	54	12	26	13
total	433	100	197	100

Table (2): Percentage of sheep and goats infected with blood parasites

heamoparasites	Examined Number on goats	Infected Number on goats	Percentage	Examined Number on sheep	Infected Number on sheep	Percentage
Theileria	175	9	6	400	24	5.1
Babesia	120	11	5.4	240	13	9.16
Anaplasma	90	–	3.52	170	6	–
total	385	20	5.30	810	43	5.19

Table (3): Hematological parasites and their effect on blood images

sheep	**species**	**W.B.C**			
		Neutrophile mean	**eosinophil mean**	**Lymphocyte Mean**	**Monocytes Mean**
	Theileria sp.	6.32 a	1.23 b	3.90 a	325.0 a
	Babesia	5.56 b	1.47 a	3.41 c	285.5 c
	Anaplasma	5.58 b	0.92 c	3.52 b	306.2 b
	Control	5.05 c	0.65 d	3.85 a	325.0 a
	P-Value	**0.05 ***	**0.01 ****	**0.05 ***	**0.05 ***
goats	***Theileria sp.***	45.7 a	9.6 a	45.25 b	3.75 b
	Babesia	46.1 a	8.3 a	47.55 a	3..60 c
	Control	42.8 b	4.2 b	48.15 a	3.95 a
Statistical analysis	**P-Value**	**0.05 ***	**0.01 ****	**0.05 ***	**0.01 ****

*Represents a significant difference compared with the control group at the level ($P \leq 0.05$).

**Represents a significant difference compared with the control group at ($P \leq 0.01$) level.

Table (4): Antibody levels in serum of sheep and goat groups under study

test	group	goats		sheep	
		female	male	female	male
		Mean F S.D	Mean F S.D	Mean F S.D	Mean F S.D
IgG	infected	3.350 ± 1.070	3.39 ± 1.60	2.902 ± 0.457	2.91 ± 0.907
	control	3.836 ± 0.743	5.10 ± 1.47	3.920 ± 1.440	4.500 ± 1.280
	Statistical analysis	T.value = 0.76 ns P.value = 0.483	T.value = 2.84 * P.value = 0.038	T.value = 1.21 ns P.value = 0.351	T.value = 2.99 * P.value = 0.047

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INFY	infected	186.7 ± 23.5	187.5 ± 19.4	121.5 ±21.4	155.5 ± 9.19
	control	139.8 ± 24.3	135.6 ± 17.4	258.0 ± 26.0	115.2 ± 10.4
	Statistical analysis	T.value = 3.54 * P.value = 0.051	T.value = 3.20 * P.value = 0.025	T.value = 2.91 * P.value = 0.045	T.value = 3.36 * P.value = 0.027

Table(5): Levels of interleukins in serum of sheep and goats under study

test	group	goats		sheep	
		female	male	female	male
		Mean F S.D	Mean F S.D	Mean F S.D	Mean F S.D
I L17	infected	136.0 ± 15.8	145.0 ± 16.1	41.90 ± 7.00	40.01 ± 5.70
	control	38.9 ± 6.23	69.9 ± 11.9	40.20 ± 8.00	47.10 ± 6.10
	Statistical analysis	T.value = 2.56 * P.value = 0.045	T.value = 3.01 * P.value = 0.037	T.value = 0.23 ns P.value = 0.822	T.value = 2.05 ns P.value = 0.242
I L12	infected	83.8 ± 18.2	99.3 ± 10.1	41.5 ± 6.6	83.7 ± 7.8
	control	47.9 ± 9.4	92.4 ± 15.0	34.0 ± 5.9	47.0 ± 7.1
	Statistical analysis	T.value = 2.86 * P.value = 0.031	T.value = 0.14 ns P.value = 0.894	T.value = 2.80 * P.value = 0.045	T.value = 3.28 * P.value = 0.028
I L6	infected	83.8 ± 18.2	99.3 ± 10.1	41.5 ± 6.6	83.7 ± 7.8
	control	47.9 ± 9.4	92.4 ± 15.0	34.0 ± 5.9	47.0 ± 7.1
	Statistical analysis	T.value = 2.86 * P.value = 0.031	T.value = 0.14 ns P.value = 0.894	T.value = 2.80 * P.value = 0.045	T.value = 3.28 * P.value = 0.028

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