Journal of Genetic and Environmental Conservation, 2024, 12(1):23-31.
www.jogec.com Print ISSN: 3007-4509, Online ISSN: 3007-4517

Study about the types of blood parasites that infect Iraqi camels and their infection rate in AL-Furat Al-Awsat Governorates

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Received: November 2th 2023; Accepted: December 6th 2023; Published: : February 165th 2024

Abstract

Field epidemiological survey was conducted to find out the types and percentage of blood parasites infecting Iraqi camels in the governorates of AL-Furat AL-Awsat governorates (Karbala, AL-Najaf, AL-Qadisiyah, Babel and AL-Muthanna). A total of 125 blood samples for both sexes were collected randomly from camels that were coming for treatment in clinics veterinary services for the aforementioned governorates for a period time from 1/4/2020 to 1/4/2021, where the ages of the camels were (less than one year and 20 years), some of these camels were in a very good health condition (un infected camels) about (27) animals; while the other not (infected camels) about (98) animals .(2) mm of blood volume was collected from the jugular vein and placed in containers containing an anticoagulant (ethylene diamine tetra acetic acid EDTA). We see the highest number and percentage of infection were, respectively, of Anaplasma parasite in (37) with a rate of (29.6%), then the Babesia parasite with a number of (25) by (20%), then the Theileria parasite with a number of (19) by (15.2%); the lowest percentage was infection with a blood parasite by trypanosomes with a number of (17) by (13.6%); Thus, the types of blood parasites recorded a significant statistical difference at the level ($P \geq 0.05$). The results of the clinical examination showed that there was a statistically significant difference ($P \geq 0.05$) between the groups of uninfected and infected camels in sex and age. The infection of females was much higher than that of males at a rate of (52%) in females, while (26.4%) in males. Upon statistical analysis of this result, it was found that there was a significant statistical difference at the level of ($P \geq 0.05$) between males and females. As for the results of examining blood slides for infection with parasites and their relationship with the age of the animal and for all types of parasites, it showed that the highest number and percentage of infection for all types of parasites was at young ages (5 years - 10 years) and the lowest percentage of infection also for all types of parasites was at ages (11 years - 15 years) this result not record statistically significant difference ($P \leq 0.05$). Our study recommended that making periodic teams to treat flies and ticks and to give medicines that treat all parasites; carrying out extensive studies on camel blood diseases because of their impact on camel productivity then affecting the economy of the country; carrying out preventive programs by mobile teams to give vaccines, vitamins and all preventive medicines; carrying out research studies to find out whether camel blood parasites are transmitted to humans or not conducting a study to find out if there are negative effects of camels infected with parasites on people who are in direct contact with them.

Keywords: Epidemiological study, Types, Infection rate, Blood parasites, Iraqi camels, AL-Furat AL-Awsat.

Introduction

The camel is one of the few animals that humans have formed a bond of familiarity and dependency with ; and it is considered a reason for the development of life in many regions of the Middle East, North Africa and Central Asia, where the Bedouins in the Arabian Peninsula raised camels and relied on them mainly for the economy; they took from their milk , meat the basic food, and they produced from leather (hair fabrics) for making Bedouin homes and clothing as well, in addition to using camels for mobility and movement due to their ability to withstand fatigue and thirst (Yam and Khomeiri, 2015). In developed areas and cities, camels are used for commercial and tourism purposes, and camels are still important to them at the present time, as they are raised to benefit from their meat, milk and hair, in addition to running camel races; Specifically, in the Arabian Peninsula (Yam and Khomeiri, 2015; Kamani *et al,* 2008). Although camels are very tolerant of harsh desert

conditions and adapt to them because of their physiological characteristics that differ from other animals, they face a variety of diseases (Alzuraiq *et al,* 2015; Swelum *et al,* 2014) that affect various systems of the animal's body Including parasites of the digestive system and parasites of the blood that affect the health of camels, leading to anemia-wasting-lack of production of milk- meat and dander- intolerance to harsh environmental conditions- inability to walk long distances and carry weights and in the case of severe injury leads to death and mortality of the animal (Karimi, 2014). Iraqi camels, like other camels, are infected with parasites in general and blood parasites in particular. They become infected with theileriosis, which is an important blood parasitic disease that infects animals and causes various clinical symptoms ranging from simple to severe and symptoms of a fatal disease. This depends partly on the animal species- host- age and types of microorganisms exposed (Mukhebi *et al*, 1992). Tropical Theileria that caused by species of the genus Theileria, has a wide distribution from North Africa to China (Mukheb *et al,* 1992). Camels are also infected with trypanosomiasis, which is considered the most important and most dangerous pathogen. It is a parasitic disease that affects camels all over the world and in Iraq; it is called by several local names in the central Euphrates governorates, such as (Al-Sura - Zariji - Flies - Al-Huiam) (Hilali *et al,* 2004; Al-Ani, 2004). It is caused by a parasite *T. evansi* infects a wide range of animals throughout the tropical and subtropical regions of the world (Losos, 1995; Abdel-Rady, 2008). Animals, including camels, are infected with anaplasmosis, which is transmitted by arthropods of ruminant animals, according to the species of the genus Anaplasma (Rickettsiales: Anaplasmataceae) (Kocan *et al,* 2004). One known species is Anaplasma spp. *A. marginale* is considered the most virulent; its infection characterized by leading to progressive hemolytic anemia, and leads to widespread economic losses in tropical and subtropical regions (Hairgrove *et al,* 2015; Silveira *et al*, 2012). *A. centrale* type is able to cause a moderate degree of anemia, but clinical outbreaks in this area are extremely rare. In tropical and subtropical regions, it is used as a live vaccine for cattle against the pathogen *A. marginale* (Carelli *et al,* 2008). It is possible to distinguish between *A. marginale* and *A. centrale* by location and characteristics from *A. centrale* by the location and the characteristics of the inclusion bodies in the erythrocytes (Ristic and Kreier, 1984). Another blood parasite is the Babesia parasite, and there is a suspicion that pyro plasmids belonging to the genera Babesia infect dromedary camels (Egbe-Nwiyi and Chaudry, 1994), but the data published so far are very limited (Al-Khalifa *et al,* 2009; Swelum *et al,* 2014). Numbers of studies and research have been published on the significant impact of Babesia infection in domestic animals -humans and some species of animals living in wildlife have generally considered this tick-borne apicomplexan to be highly specific to a particular host species (Al-Khalifa *et al*, 2009). Despite the importance of camels and the importance of parasitic diseases that afflict them and caused many economic losses, there is a dearth of research and information about them in Iraq. Therefore, we were chosen for this research to conduct a field survey on the types of blood parasites that infect Iraqi camels and their infection rate specifically in the governorates of the Middle Euphrates, which include (Karbala – AL-Najaf – AL-Qadisiyah –Babel – AL-Muthanna).

Materials and Methods

Choosing animals of research and period time: The research included (125) camels randomly selected from the Iraqi camels for both sex that were brought for examination and treatment in the veterinary clinics of AL-Furat Al-Awsat governorates (Karbala – AL-Najaf – AL-Qadisiyah –Babel – AL-Muthanna) by (25) animals from each governorate for the time period from 1/4/2020 to 1/4/2021, their ages ranged from (less than 1 year - 20 years) for both sexes.

Clinical examination of camels: We conducted a clinical examination of (125) animals from which blood samples were collected. Some of them were in very good health, and no observation was recorded on them when conducting the clinical examination for them. When conducting a microscopic examination of their blood slides, it was also found that they were free of all diseases, including blood parasites; Their number is (27) animals, while the number (98) animals were infected with blood parasite, some of them did not show symptoms of infection with blood parasites, but by laboratory examination, the result was infected, as the number was (75) animals, and the other group showed all the symptoms of infection with blood parasites, which included weakness - depression - Emaciation - coarseness of the hair - softness and atrophy of the hump - a collection of marshmallows in different parts of the animal's body - hematuria - enlarged lymph nodes - high temperature. The most important point of the examination was the presence of flies and ticks (Tabanus, Stomoxys and

tick-infested camels). The number of these camels was (12) As for the other part of the animals, the clinical examination showed some clinical signs, which leads to suspicion of the presence of blood parasites, whose number was (11) animals. Thus, the results of the clinical examination were divided into three groups (12). (Asymptomatic - subclinical - clinical) We relied on clinical examination (Baraka TA.; 2000; Radostits *et al,* 2008).

Collecting blood samples: (125) blood samples were collected from the camels that were examined and used in the research, where sterile and clean syringes with a capacity of (5) mm were used to collect (2) mm of blood volume from the jugular vein after sterilizing the area by wiping the area with ethyl alcohol and then placed in tubes containing anticoagulant (ethylene diamine tetra acetic acid EDTA) and move the tubes quietly and accurately to mix the substance with the blood to prevent its coagulation to make slides and stained them by Giemsa stain (Qablan *et al,* 2012).

Microscopic examination: Microscopic examination is conducted to see the morphological shape of the blood parasites to distinguish them according to their shape based on (Soulsby, 1982; Rahbari *et al,* 2008). To perform the microscopic examination, blood smears of both types (thick and light) are made by taking two blood drops, and each point is placed on a clean glass slide and spread, one of which is spread thickly and the second is spread Lightly and dried, then fixed with methanol for (5) minutes, then stained with Giemsa stain for (30) minutes, and finally washed with distilled water, dried and examined under an oil lens at a power of 100X according to (William *et al,* 2019; Luekins, 2002).

Statistical analysis: The data obtained through our study were statistically analyzed using chi-square tests (X^2) at $p \leq 0.05$ to analyze the differences in groups of different ages, sex, and rate of parasitemia for samples collected randomly (Leech *et al*, 2011).

Results and Discussion

The results of the examinations of (125) animals showed that there were (27) animals with a rate of (21.6%) for both sexes free from all diseases, including blood parasites, and (98) animals with a rate of (78.4%) for both sexes infected with blood parasites, as shown in Figure (1).

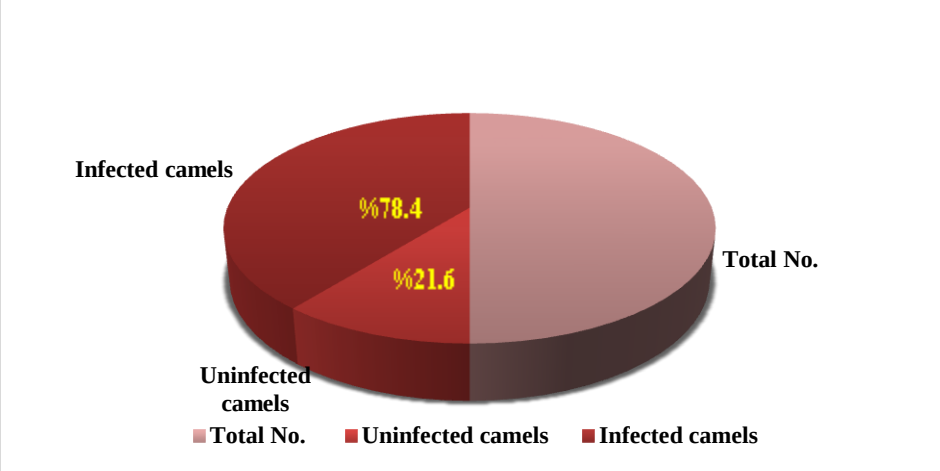


Figure (1): Shows the total number of examined camels also the number of infected and uninfected camels, and the percentage of infection for both sexes

When conducting a clinical examination of the affected animals, they were divided into three groups according to the appearance or absence of clinical symptoms, as shown in Figure (2). The first group was infected and did not show pathological symptoms at a rate of (38%) of the total percentage, which is the largest percentage; this group was called (Asymptomatic group) while the second group showed all typical clinical signs and symptoms such as paleness of the mucous membranes - jaundice - high fever - general weakness - emaciation - coarseness of the hair and inhomogeneity of its distribution on the skin - enlarged lymph nodes - hematuria - escaping from the sun and edema in deferent places of the body of the animal ;the percentage of it was (6%) of the total percentage; this group was called the clinical group. As for the third group, it showed some partial clinical signs and

overlapped with some unclear pathological symptoms, which leads to suspicion of infection with blood parasites; when conducting a microscopic examination, it was confirmed the infection; it was called the subclinical group; its percentage was (6%) of the total percentage, and this is consistent with (El-Naga and Barghash, 2016).

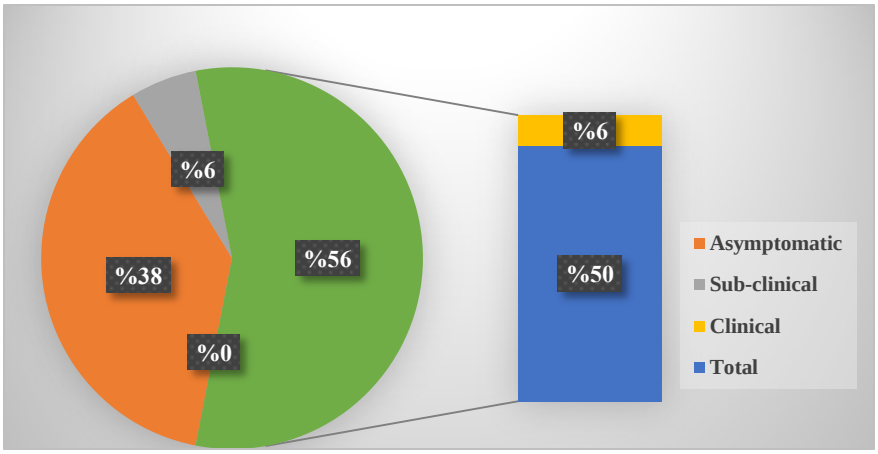


Figure (2): shows how to divide the number of infected camels into three groups (Asymptomatic - subclinical - clinical signs) according to the clinical examination

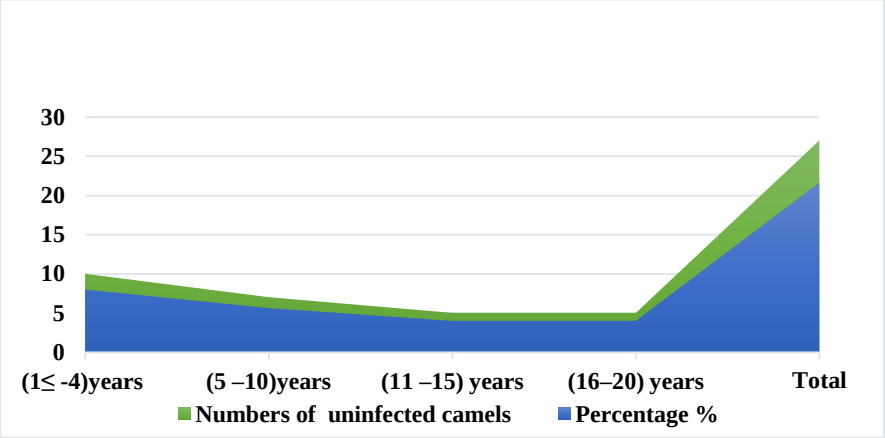


Figure (3): explains the ratio of the number of healthy camels to the total number of camels by age groups

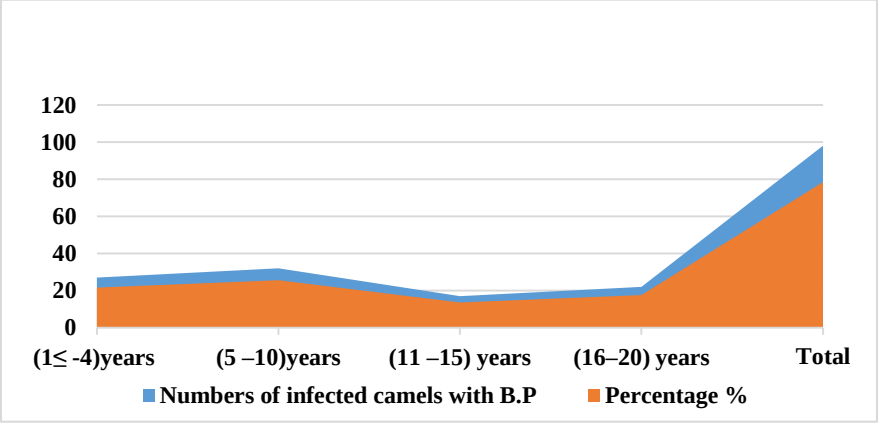


Figure (4): shows the ratio of the number of infected camels to the total number of camels by age groups

Table (1): shows the total number of examined camels, each group of uninfected camels and infected camels with blood parasites, by age groups

Age / year	No. Infected camels with B.P	%	No. of Uninfected camels	%	Total No.	%	ssd (p-value)
(1≤ -4)	27	21.6	10	8	37	29.6	P ≤ 0.05
(5 –10)	32	25.6	7	5.6	39	31.2	
(11 –15)	17	13.6	5	4	22	17.6	
(16–20)	22	17.6	5	4	27	21.6	
Total	98	78.4	27	21.6	125	100	

Abbreviations: No. means: number, B.P: means: Blood parasite, %: means: percentage, ssd: means: significant statistical difference (p-value).

Table (1) shows the total number of examined camels in the research; the number of a group of uninfected camels and a group of infected camels with blood parasites, according to the age groups for both sexes.

As for the results of the infection and its relationship with the sex of the animal; it is shown in Table (2), where the infection was much higher in females than in males; females were (65) animals, with a rate of (52%) of the total number of infections, while the number of males was (33)with a rate of (26.4%) from the total number of infections, when conducting the statistical analysis of this result, it was found that there is a statistical significant difference at the level ($P \geq 0.05$) between the male and female groups ; this result is consistent with the results of the study (Salim *et al,* 2010) ,where his study recorded (46/69) (66%) in milk female animals more than in males in the north of Tunisia, while the results of our study do not agree with (Al-Khaledi, 2008), as it recorded his study on the blood parasites of cows and camels, so the result was (52.29%) from 114 cows and (54.44%) from 202 female camels in Diwaniyah governorate. While a study (Ahmed *et al,* 2004), in Kingdom of Saudi Arabia did not record any difference in infection between males and females ;To explain the result of our study, the higher rate of infection in females than in males, especially in males of young ages, according to what we learned about during the study and discussion with breeders, may be due to the approach that breeders and owners of the animals; they slaughter males at young ages and keep only males of good health and fertility, which their number is very few in the herd by One male to ten females, while the females keep them all for reproduction, pregnancy and childbirth, thus they are exposed to infection over time and this leads to increase the percentage of infection in females than it is in males.

Table (2) shows the total number of camels, the number of uninfected and infected camels, and their relationship with the sex of the animals. It shows that the infection rate was higher in females than it is in males.

The results of examining slides of blood samples stained with gemza stain for research camels that were made from camel blood in AL-Furat Al-Awsat governorates (Karbala – AL-Najaf – AL-Qadisiyah – Babel – AL-Muthanna). The results showed that there are four types of blood parasites infecting camels in these governorates Shown in Figure (5) and Table (3). The infection was recorded with each of the parasites (trypanosomiasis - thaleria - babesiosis - anaplasma), where the highest number of infection with the anaplasma parasite was (37), with a rate of (29.6%), then the infection with the Babesia parasite was (25). At a rate of (20%), then infection with the thaleria parasite numbered (19) at a rate of (15.2%). The least number and percentage of infection was in trypanosomiasis parasites number and percentage, respectively (17), at a rate of (13.6%). We also noticed that in some blood slides of the same animal there was an mixed infection between two or more or four parasites of blood parasites in one animal. Thus, when we analysis the data found a statistical difference concerned with the multiplicity of infection in one animal, and there was no significant statistical difference at the level of $P \leq 0.05$ in the quality of infection for one type of blood parasite. These results are consistent with (Ismeal *et al,* 2016; Faham *et al,* 2015; Al-Amery *et al,* 2017). Table (3) shows the total number of

infected camels, the four types of infected blood parasites, the number and the percentage of each type of parasite. The results of examining blood samples and their relationship with the age of the animal for both sexes and for all types of parasites as shown in Table (4) show that the highest number and infection rate for all types of parasites was in young ages (5 years - 10 years) with a number of (32) with a rate of (25.6%). The lowest infection rate for all types of parasites was at ages (11 years - 15 years) with a number of (17) at a rate of (13.6%). When analyzing the data statistically, it was found that there was no significant statistical difference at the level (P ≤ 0.05) between the type of infection and the age groups. Thus, our study agrees with (Bhutto *et a*l, 2010; Barghash *et al*, 2014; Barghash, 2010).

Table (2): Shows the numbers of total camels, the numbers of uninfected and infected camels and their relationship with the sex of animals

Sex	No. of Infected camels with B.P	%	No. of Uninfected camels	%	Total	%	ssd (p-value)
Male	33	26.4	16	12.8	49	39.2	P ≤ 0.05
Female	65	52	11	8.8	76	60.8	
Total	98	78.4	27	21.6	125	100	

Abbreviations: No. means: number, B.P: means: Blood parasite, %: means: percentage, ssd: means: significant statistical difference (p-value).

Table (3): shows the total number of infected camels, the types of blood parasites, the number and the percentage of infection for each type

No.of Infected camels with B.P		Babesia spp		Theileria spp		Anaplasma spp		Trypanosoma spp		ssd (p-value)
No.	%	No.	%	No.	%	No.	%	No.	%	P ≤ 0.05
98	78.4	25	20	19	15.2	37	29.6	17	13.6	

Abbreviations: No. means: number, B.P: means: Blood parasite, %: means: percentage, ssd: means: significant statistical difference (p-value).

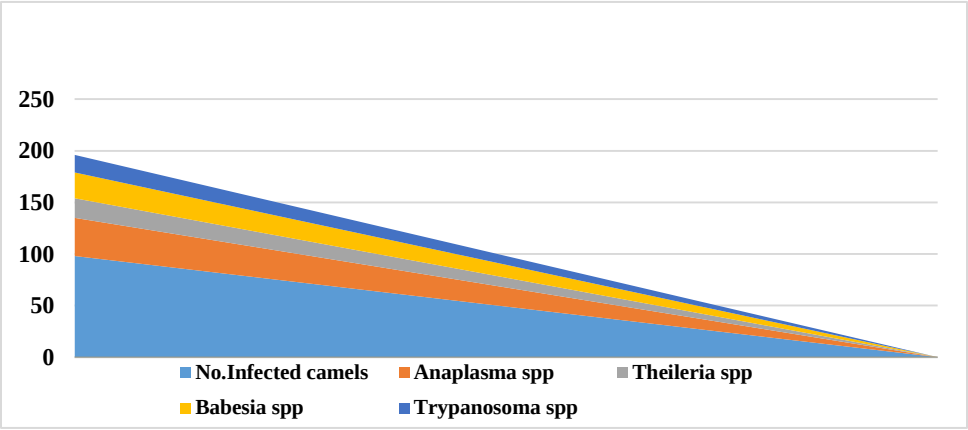
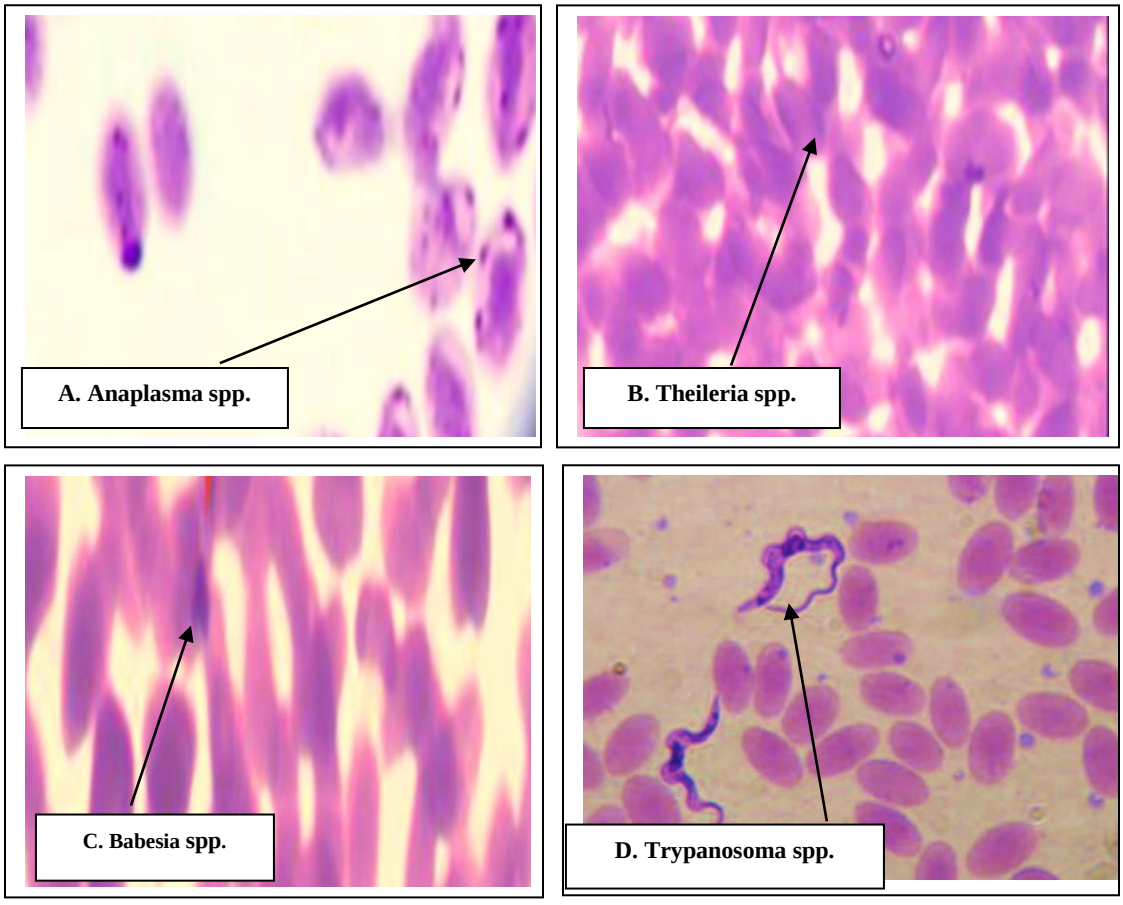


Figure (5): shows the total number of camels infected with blood parasites, the four types infected with them, and the number and percentage of each type of parasite

Table (4): shows the total number of infected camels, types, number and the percentage of infection for each type of blood parasite by age group

Age / year	Total No. of Infected camels		Babesia spp		Theileria spp		Anaplasma spp		Trypanosoma spp		ssd (p-value)
	No.	%	No.	%	No.	%	No.	%	No.	%	
(1≤ -4)	27	21.6	5	4	4	3.2	10	8	4	3.2	P ≤ 0.05
(5 –10)	32	25.6	6	4.8	4	3.2	8	6.4	3	2.4	
(11 –15)	17	13.6	6	4.8	5	4	10	8	5	4	
(16–20)	22	17.6	8	6.4	6	4.8	9	7.2	5	4	
Total	98	78.4	25	20	19	15.2	37	29.6	17	13.6	

Table (4) explains the relationship of infection with blood parasites according to the age group for both sexes; It shows that there is no statistical significant difference at the level of P ≤ 0.05 between the age groups and the type of infection. As for the results of examining blood smears to distinguish the shape of bloody parasites, they are illustrated by Figure (6), and the shape was distinguished according to (William J.; *et al*; 2019); (Luekins, A.G.; 2002).



Figures (6): shows blood parasites the genus of A. anaplasmosis, B. thaleria, C. babesiosis, and D. trypanosomiasis.

Recommendations

1. Work in periodic teams to treat flies and ticks, and to give medicines that treat all parasites.
2. Carrying out extensive studies on camel blood diseases because of their impact on camel productivity and, consequently, on the country's economy.
3. Implementation of preventive programs by mobile teams to give vaccines, vitamins and all preventive medicines.
4. Conducting research studies to find out whether camel blood parasites are transmitted to humans or not.
5. Conducting a study to find out whether there are negative effects for people who deal with camels, including breeders, farmers, owners and herders of camels infected with blood parasites.

Declarations

I hereby declare that the work on this research is solely my own.

-There are no co-researchers with me.

-There is no conflict of interest with respect to the publication or funding of this manuscript.

- Please contact me with this e-mail: zahra.make@yahoo.com to obtain any data or information about the search

References

Al-Ani FK. "Camel Management and Diseases, 1st Edition". Al-Shraq Printing Press and Dar Ammar Book Publishing, Amman, Jordan; (2004).

Al-Amery, A.M.; Faraj, A.A. and Majeed, S.A.; (2017). Detection of haemoprotozoa in camel in AL-Najaf province, Iraq. Department of Parasitology, College of Veterinary Medicine, University of Baghdad/Iraq. IJABR.7 (2): 238-241.

Abdel-Rady A.; (2008). Epidemiological studies (parasitological, serological and molecular techniques) of *Trypanosoma evansi* infection in camels (*Camelus dromedaries*) in Egypt. Vet World 1: 325-328.

Ahmed, S.; Butt, A.A.; Muhammad, G.; Athar, M. and Khan, M.Z.; (2004). Haematobiochemical studies on the haemoparasitized camels. Inc. Agri. Biol. 6(2): 331-334.

Al-Khaledi, M.J. ;(2008). Epidemiological study of (Theileriosis, Babesiosis and Anaplasmosis) in cattle of Al-Qadisiya province. M.S. thesis. Vet. Med. College Baghdad Uni. In Arabic.

Al-Khalifa MS., Hussein HS., Diab FM., Khalil GM.; (2009). Blood parasites of livestock in certain Regions in Saudi Arabia. Saudi J Biol Sci 16: 63-67.

Alzuraiq F., Faye B., Lesnoff M. (2015). Use of demographic model to assess the potential change in camel population and economy: the example of Saudi Arabia, In: Proc. of 4th Conference of ISOCARD, "Silk Road Camel: The Camelids, Main Stakes for Sustainable Development", June 8-12, 2015 Almaty, Kazakhstan, Konuspayeva G. (Ed.), Special Issue of Scientific and Practical Journal Veterinary #2 (42) 2015, oral communication, 312-314.

Baraka TA. ;(2000). "Clinical studies of selected ruminal and blood constituents in dromedary camels affected by various diseases". Act Veterinarian Brno 69 (2000): 61-68.

Barghash SM.; Abou El-Naga TR.; El-Sherbeny EA.; Darwish AM.; (2014). Prevalence of Trypanosoma evansi in Maghrabi Camels (Camelus dromedaries) in Northern-West Coast, Egypt using Molecular and Parasitological Methods. Acta Parasitology Glob 5: 125-132

Barghash, S.M.; (2010). Study of genetic variability and prevalence of *Trypanosoma evansi* in domestic animals in Egypt. PhD Thesis, Faculty of Science, Ain Shams Univ., Egypt.

Bhutto B.; Gadahi JA.; Shah G.; Dewani P.; Arijo AG.; (2010). Field investigation on the prevalence of trypanosomiasis in camels in relation to sex, age and herd size. Pak Vet J 30: 175-177.

Carelli G., Decaro N., Lorusso E., Paradies P., Elia G.; (2008). First report of bovine anaplasmosis caused by Anaplasma centrale in Europe. Ann N Y Acad Sci 1149: 107-110.

Egbe-Nwiyi TN. and Chaudry SUR; (1994). Trypanosomosis: Prevalence and pathology of camel of arid zone of north eastern Nigeria. Pakistan V26-El-Naga TRA and Barghash SM.; (2016). Blood Parasites in Camels (*Camellus dromedaries*) in Northern West Coast of Egypt. J Bacterial Parasitology 7: 258. doi: 10.4172/2155-9597.1000258.eterinary Journal 14: 24-27.

Faham, K.; Doosti, A.; Koohi, A.; Chehelgerdi, M.; MokhtariFarsani, A. and Chengula, A.A.; (2015). Determination of the presence of Babesia DNA in blood samples of cattle, camel and sheep in Iran by PCR. Arch. Biol. Sci., Belgrade, 67 (1), 83-90.

Hairgrove T., Schroeder ME., Budke CM., Rodgers S., Chung C.; (2015). Molecular and serological in-herd prevalence of *Anaplasma marginale* infection in Texas cattle. Prev Vet Med 119: 1-9. 17.

7-Hilali M, Abdel-Gawad A, Nassar A, Abdel-Wahab A, Magnus E.; (2004). Evaluation of the card agglutination test (CATT/T. evansi) for detection of Trypanosoma evansi infection in water buffaloes (*Bubalus bubalis*) in Egypt. Vet Parasitology 121: 45-51.

Ismeal, A.B.; Swelum, A.A.; Khalaf, A.F. and Alowaimer, A.N.; (2016). FIRST EVIDENCE of natural ANAPLASMOSIS in 92 *Camelus dromedaries* in Saudi Arabia. Pak. Vet. J. 23 (1):95- 100.

Kamani J, Usman TA, Onyeamaechi EG, Usman MA, Kida SM, et al. (2008) . Hemoparasites of camels (*Camelus dromedaries*) in Maiduguri, Nigeria. Anim. Res Int 5: 838-839.

Karimi A, Rahbari S, Yousef A.; (2014). Blood parasites of camels from central regions of Iran: comparative evaluation of various detection techniques and serum protein components. J Adv. Parasitology 2: 1-4.

Kocan KM., De La Fuente J., Blouin EF., Garcia-Garcia JC.; (2004). Anaplasma marginale (Rickettsiales: Anaplasmataceae): recent advances in defining host pathogen adaptations of a tick-borne rickettsia. Parasitology 129: 285-300.

Leech, N. L.; Barrett, K.C. and Morgan, G.A.; (2011). IBM SPSS for Intermediate Statistics. 4th edition. Taylor and Francis Group. LLC. USA.

Losos, G.J. ;(1995). Infectious Tropical Diseases of Domestic Animals. Chapter 3, Trypanosomiasis, P:182-318. London. Longman. Higgins, A.J. (1985). Protozoal diagnosis of camels. Brit. Vet. J. 141: 87.

Luekins, A.G.; (2002). Method for diagnosis of Trypanosomiasis in livestock. Men. Inst. Dswaldo cruz, Riode Janero. 96 (5): 409 – 415.

Mukhebi AW., Perry BD, Kruska R.; (1992). Estimated economics of theileriosis control in Africa. Prev Vet Med 12: 73-85.

Qablan, M.; Sloboda, M.; Jirku, M.; Dwairi, S.; Sami Amr, Z.; Horin, P.; Lukes, J. and Modry, D.; (2012). Quest for the piroplasms in camels: Identification of Theileria equi and Babesia caballi in Jordanian dromedaries by PCR. Vet. Parasitology., 186, 456-460.

Radostits, O. M.; Gay, C. C.; Hinchcliff, K. W. and Constable, P. D.; (2008). Disease Associated with Protozoa. 10th edition. In: Veterinary Medicine: A Textbook of disease of cattle, horses, sheep, pigs and goats. Saunders Elsevier.; 1483-1540.

Rahbari, S.; Nabian, S.; Khaki, Z.; Alidadi, N. and Ashrafi élan, J.; (2008). Clinical, Hematological and Pathological Aspects of Experimental Ovine Babesiosis in Iran, Iranian J. of Vet. Research. 9, 59-64.

Ristic M. and Kreier JP.; (1984). Family III. Anaplasmataceae Phillip 1957. In: Bergey's Manual of Systematic Bacteriology (Vol. I) Kreig JG, Hoh JG (eds.) Williams & Wilkins, Baltimore, USA, pp. 719-729.

Salim, A. Y.; Telmadarraiy, Z.; Vatandoost, H.; Chinikar, S.; Oshaghi, M.; Moradi, M.; (2010). Hard ticks on domestic ruminants and their seasonal population dynamics in Yazd Province, Iran. Iran J. Arthropod Borne Dis.;4(1):66–71.

Silveira JA., Rabelo EM., Ribeiro MF.; (2012). Molecular detection of tick-borne pathogens of the family Anaplasmataceae in Brazilian brown brocket deer (Mazama gouazoubira, Fischer, 1814) and marsh deer (Blastocerus dichotomus, Illiger, 1815). Trans bound Emerge Dis 59: 353-360.

Soulsby, E.J.L.; (1982). Helminthes, Arthropods and Protozoa parasites of domesticated Animals, Bailere Tindal, London; 232-233.

Swelum AA, Ismael AB, Khalaf AF, Abouheif MA.; (2014). Clinical and laboratory findings associated with naturally occurring babesiosis in dromedary camels. Bull Vet Inst. Pulaway 58: 229-233.

William J.; Reagan; Armando R.; Irizarry Rovira; Dennis B.; DE Nicola ;(2019). Veterinary Hematology: Atlas of Common Domestic and Non-Domestic Species 3rd Edition.

Yam BAZ and Khomeiri M. "Introduction to Camel origin, history, raising, characteristics, and wool, hair and skin: A Review". *Research Journal of Agriculture and Environmental Management* 4.11 (2015): 496-508.