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Ectoparasites and Haemoparasites of the Camel (*Camelus dromedarius*) in Southern Algeria

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ABSTRACT:

The present study aims at investigating the prevalence and identifying ectoparasites and haemoparasites in camels (*Camelus dromedarius*) in the Laghouat region. For this, an experimental work (from December 2022 to June 2023) was carried out on a sample of 115 camels. We used Giemsa-stain blood smear method to search for haemoparasites. The results showed an overall infestation rate of 33.9%, with the presence of the following ectoparasites (ticks): *Hyalomma dromedarii* (32%), *Hyalomma impeltatum* (9%) and haemoparasites: *Babesia spp.* (24.3%), *Theileria spp.* (14.8%) and *Trypanosoma spp.* (2.6%). Statistical analysis revealed a significant influence of breeding method, aim breeding, clinical status and study site on the prevalence of ectoparasites and haemoparasites ($P < 0.05$). At the end, parasites represent a major threat to camels' health in Laghouat region. Therefore, future studies should be conducted to better understand the epidemiology of these parasitic diseases and their potential risks and dangers on the economic and public health impact.

Keywords: Ectoparasites; Haemoparasites; Blood smear; camels; Laghouat.

1. Introduction

A camel is one of the oldest animal species in the world. It belongs to the class Mammalia; the order Artiodactyla; sub-order Tylopoda and family Camelidae (Saidi et al., 2022) [1]. It symbolizes the human survival in deserts and is tied to the nomadic civilization that flourished in arid and semi-arid areas. It is known as being the best means of transporting goods. Camels produce milk, wool and meat (Abou El-Naga, 2016) [2]. In Algeria, this animal plays a crucial role in maintaining food safety for saharian steppe communities (Meguellati-Kanoun et al, 2018) [3] with an estimated number of 416,519 heads essentially concentrated in saharian wilayates (Saidi et al., 2021) [4].

Nowadays, camel is subject to many parasitic infections (endo and ecto) that represent the main obstacle to the improvement of their health (Majidi et al, 2015) [5]. Haemoparasitic disease has a serious effect on camels' productivity, health and working resistance (Tamoor et al., 2019) [6]. Ectoparasites are considered as the major problem that affects camels' health, productivity and performance. Among ectoparasites of camels, various species of ticks have been identified. The latter can be a vector of some pathogenic agents such as bacteria, virus and protozoa. These ticks are important in the public health and veterinary medicine (Shamsi et al., 2020) [7].

Few researches have been carried out on diseases that affect camels in Algeria. Therefore, there still much more efforts to do in order to know more about the prevalence, the different species of parasites involved, possible risks and economic effects of ectoparasites and haemoparasites on camel population in Algeria and particularly in Laghouat region.

2. Materials and methods

Presentation of the study area

Laghouat is a region that stretches over an area of about 27516.6 Km². It is composed of 24 municipalities and is located on two range areas: steppe and pre-saharian. It is at an average altitude of 900 meters with an average rainfall of 100 mm (50-150 mm) and with an average temperature of 22.53 °C ranging from 16 °C to 29 °C.

Study design and animals

In order to identify ectoparasites and haemoparasites of camel in the Southern Algeria, a survey was carried out in Laghouat province. The study included 8 farms from 5 different regions: Laghouat, Ain Madhi, Tadjrouna, El Kheneg and Hassi R'Mel (**Figure. 1**).

Farm Characteristics

To carry out our study, we took 115 samples from 8 farms. Each farm has different characteristics (Table 1).

Characteristics of the animals

The following table represents the characteristics of the animals (Table 2).

Collection and conservation of ectoparasites

To collect ectoparasites, all body parts of sampled camels were visually inspected, ectoparasites were counted, and we made an estimate of the number, isolated ticks from each individual host in a vial identified with a label. When we looked for ectoparasites, we only found ticks.

Ticks collected were preserved in hermetically sealed bottles by adding solution (80% ethanol, 15% distilled water, 5% glycerol and 1% chloroform) (Walker et al., 2003) [8]. They were identified using a magnifying glass based on guides (Estrada-Peña et al., 2017) [9].

Collection and conservation of blood samples

The blood sample should be taken as sterile as possible by venipuncture. In large mammals, the jugular vein or a tail vein were be used. For the collected blood samples placed in tubes with anti-coagulation, it is necessary to harmonize the sample as quickly as possible by moving the tube up and down and store them in the fridge to take it quickly to an analytics informant. After that, we used Giemsa-stain blood smear method to search for haemoparasites in the laboratory.

Statistical analysis

After the examination of 115 animals listed on five zones by specific techniques, the method of analysis adopted in this study was a descriptive statistical analysis. We used SPSS version 21 for the calculation of the prevalence of the infestation. Chi 2 test was performed to determine the relationship between the prevalence of the infestation and some factors such as (age, sex, breeding system and aim).

3. Results

In our study, 33.9% of camels were infected with parasites of a total of 115 examined.

Ectoparasites

According to our data, 28% of the camels were infected by ectoparasites (Ticks) of a total of 115 camels examined.

We have inventoried 2 species of ectoparasites, belonging to 1 phylum (Arthropoda), classes (Arachnida), orders (Ixodida) and family (Hylomma). The order of Ixodida was highly represented with 2 species (*Hylomma dromedarii* and *Hyalomma impeltatum*) (Figure 2 et 3).

Prevalence of ticks according to their species

We found a total of 16 females and 9 males of the species *Hyalomma Impeltatum* with numbers 25, and 162 of *Hyalomma dromedarii* divided into 135 males and 27 females. Both species are represented by 187 adults with a total number of males and females (Figure 4).

Association of parasites (Poly parasitism)

The presence of a single parasite species was reported in 22 animal samples (19.25 %), and the cohabitation of two parasites was reported in 10 animals (8.75 %) (Table 03).

Prevalence of ectoparasites by age

Our data presented in the following figure revealed that 27% of the adults have been infested by the ectoparasites. In young animals, the rate was at 31 % (P=0.76) (Figure 5).

Prevalence of ectoparasites by sex

From the results presented in the next figure, 22% and 30% of males and females were infested by ectoparasites respectively (P=0.48) (it is important to mention that in our work, more females examined than males) (Figure 6).

Prevalence of ectoparasite by breeding method

According to our data, 76 % of camels were infested in sedentary. No case for the other breeding systems (P=0.00) (Figure 7).

Prevalence of ectoparasites by clinical status

In our current work, 71% of camels presenting diseases were infested by ectoparasites, while 18% of healthy ones were affected. Statistical analysis revealed that clinical status of animals influenced the infestation rate (P=0.00) (Figure 8).

Prevalence of ectoparasites by study site

Figure 9 showed that in Ain Madhi, 91% of camels were infested, while in Kheneg, the rate was at 86% (P=0.00).

Blood Test Results

During the study period, blood samples were taken from 115 camels, 83 of which were females and 32 were males. Data showed that 3 parasitic species of blood were present in 28 camels (24.34%). These species were represented by *Trypanosoma spp*, *Babesia spp* and *Theileria spp*. *Babesia spp* was most reported with a prevalence of 24.34 % (28 camels), followed by *Theileria spp* in 17 camels with 14.78%, then *Trypanosoma spp*, 2.60% (3 camels) (Figure 10).

Prevalence of haemoparasite according to their species

In this study, the most dominant haemoparasite infesting camels was *Babesia spp* (24.34%/ 28 camels), followed by *Theileria spp* (14.78 %/ 17), and finally *Trypanosoma spp* (2.6%/ 3) (Figure 11).

Association of parasites (Poly parasitism)

The presence of a single species of haemoparasite (*Babesia sp*) was reported in 9 camels (7.82%), the cohabitation of two haemoparasites (*Babesia spp+Theileria spp*) in 16 cases (13.91%), and (*Babesia spp+Trypanosoma spp*) in 2 samples (1.74%). The cohabitation of three parasites (*Babesia spp + Trypanosoma spp+ Theileria spp*) was reported in 1 animal (0.87%) (Table 4).

Relationship between haemoparasite infestation and other parameters Prevalence of haemoparasite according to age

In this study, the prevalence of infection in young camels was 25 % which exceeded a bit that noticed in adults (23%) (P= 1) (Figure 12).

Prevalence of haemoparasite by sex

Figure 13 showed that the prevalence of infection in females was 22%, less than that recorded in males (28%) (P= 0.47) (Figure 13).

Prevalence of haemoparasite by breeding method

In sedentary breeding, 48% of camels were infected, while 13% was the rate of infestation noticed in transhumance (P=0.00) (Figure 14).

Prevalence of haemoparasites by clinical status

In the current work, 6 % of healthy camels were infected. On the other hand, all the animals carrying diseases showed parasitism infestation (P=0.00). Thus clinical status had an effect on haemoparasite rate (Figure 15).

Prevalence of haemoparasite by study site

According to data presented in figure 16, in Ain Madhi, a prevalence of infestation at 73% was recorded, followed by that found in Kheneg (29%) and in Tadjrouna (13%) (P=0.00); the study site is related to haemoparasite infestation (Figure 16).

4. Discussion

In the current work, the ectoparasites identified belong to the arthropod branch, it indicates a fauna basically constituted by the Ixodids (ticks). Among the ticks found, *Hyalomma impeltatum* was less frequent than *Hyalomma dromedarii*. Blood smears revealed the presence of 3 haemoparasites: *Babesia spp*, *Theileria spp*, and *Trypanosoma spp*. All of the following studies corroborate our findings.

In Laghouat region, camels are the hosts for specific species of ticks. A total of 187 ticks were collected from 32 camels. Ben Youcef et Labidi (2017) [10] recorded in EL Oued zone 116 ticks in 21 camels. ALanazi et al. (2018) [11] in another study performed in Saudi Arabia concerning 116 camels, they revealed 79 of cases infested by ticks. A total of 218 ticks were collected from these 79 camels and 5 different tick species were identified. During our study, we noted that *Hyalomma spp* was the most recorded. High results were revealed previously

worldwide: Van Straten and Jongejan (1993) [12] in Egypt (95.6%); Idris et al. (2000) [13] in Oman (89.55%); Antoine-Moussiaux et al. (2005) [14] in the Agadez region of Niger (100%); Bouhous (2006) [15] in Adrar, Algeria (99.41%); El Ghali et Hassan (2009) [16] in Northern Sudan, (89.0%). This result could be explained by the selectivity of this species for the dromedary or its concentration in the desert regions and because of their adaptation to the unfavorable climatic conditions of the Sahara, this species being able to carry out several cycles in the year (Bouhous et al., 2008) [15]. In another experiment, the overall prevalence of mange mite infestation ranged from 10.7% to 94.1% in camels from Ethiopia (Chalchisa and Bersissa, 2023) [17].

During our study, we found high prevalence of *Hyalomma dromedarii*, more than that mentioned by Gharbi (2013) [18] in Central Tunisia (45%). On the other hand, the rate of *Hyalomma impeltatum* infestation was less than that found in Tunisia, 53% (Gharbi, 2013) [18]. In Iran, 90.7% of the ticks identified were *Hyalomma dromedarii* (Champour et al., 2013) [19].

In this study, we noticed a high infestation rate by *H. dromedarii*, with 16.66% in females and 33.83% in males, meanwhile, among those infected by *H. impeltatum* 50% were females and 36% were males. ALanazi et al. (2018) [11] in Saudi Arabia found 27.5% of males, and 14.2% of females were infested by the same parasite in a total of 41.7%, and for *H. impeltatum* with a total of 12.8% divided into 11% males, 1.8% females. In addition, the parasitism rate was higher in females than in males which is perfectly consistent with previous data (Bouhous et al. 2008; Ashraf et al., 2014) [15,20]. In the same context, ALanazi et al. (2018) [11] in Saudi Arabia found 71% Vs 59.3% of infested females/males, respectively. On the contrary, Morel et al. (2000) [21] reported that ticks are usually more common in males than in females.

For the relationship between camels age and ectoparasite infestation, our result indicated that adults were less infected than young. It is obvious that young animals were more affected due to lower immunity compared to adults (Saber, 2015) [22].

Haemoparasites

In the present study, the overall prevalence of haemoparasitic infestation in camels was higher than those reported previously: 14.2% (Kamani et al., 2008) [23]; 4.85% in Iran (Karimi et al., 2015) [24]. In other studies, high rates were recorded: 79 % in Maiduguri Nigeria (Rabana et al., 2011) [25], 60.4% in Nigeria (Wakil et al., 2016) [26], and 77.34% in Egypt (Abou El-Naga, 2016) [2].

Amongst the haemoparasites found in the examined camels, *Babesia spp*, *Theileria spp* and *Trypanosoma spp* were recorded at different prevalence rates (24.34%, 14.78% and 2.6% respectively). In Egypt, from a total of 331 camels, data revealed the presence of trypanosome 168 (50.8%), *Theileria spp* 157 (47.4%), and *Trypanosoma spp* 67 (20.24%) (Abou El-Naga & Barghash, 2016) [2].

Our result showed a high infestation prevalence by *Babesia spp*, compared to previous microscopically findings reported in camels from Egypt (11.8%) (Abou El-Naga & Barghash, 2016) [2] and close rate to that found in Nigeria (24.3%) (Wakil et al., 2016) [26]. Similarly, the molecular prevalence of *Babesia spp* among Iranian and Egyptian camels was lower (6.6% and 5%, respectively) (Khamesipour et al., 2015; Abouzaid et al., 2022) [27,28].

Microscopic examination showed the presence of *Trypanosoma spp* in few cases which was less than the results found previously: 7.4% (Allali and Khader, 2021) [29] in Djelfa, Algeria and 11.11%, (Mossaad, 2017) [30] in Sudan. The prevalence of the infection by *Trypanosoma* in our work was less than those reported in Tataouine (10.6%) (Lachtar et al., 2017) [31], in Northern Tunisia (10.6%) (Salemi et al., 2019) [32], and in Eastern Ethiopia with 3.9% (Tadesse et al., 2012) [33].

The relationship between the sex of the camels studied and the rate of haemoparasites showed

that females were less infested than males, in agreement with previous data in Egypt (Abou El-Naga & Barghash, 2016) [2].

According to the age, adults were less infected than young camels. In Egypt, Abou El-Naga and Barghash, (2016) [2] mentioned that adults were more infected than young animals.

In this study, statistical analysis revealed that breeding method and aim, clinical status and study site had a significant influence on the prevalence of ectoparasites and haemoparasites.

5. Conclusions

This work highlighted the presence of different species of ectoparasites and haemoparasites of camels in the Laghouat region with different rates. It also indicated that many factors can influence the infestation rates (Sex, clinical status, age, breeding system). Therefore, further investigations in Sahara regions seem to be important to implement a coherent integrated pest control strategy and raising awareness among animal breeders about the multiple diseases that can affect their animals.

Figures:

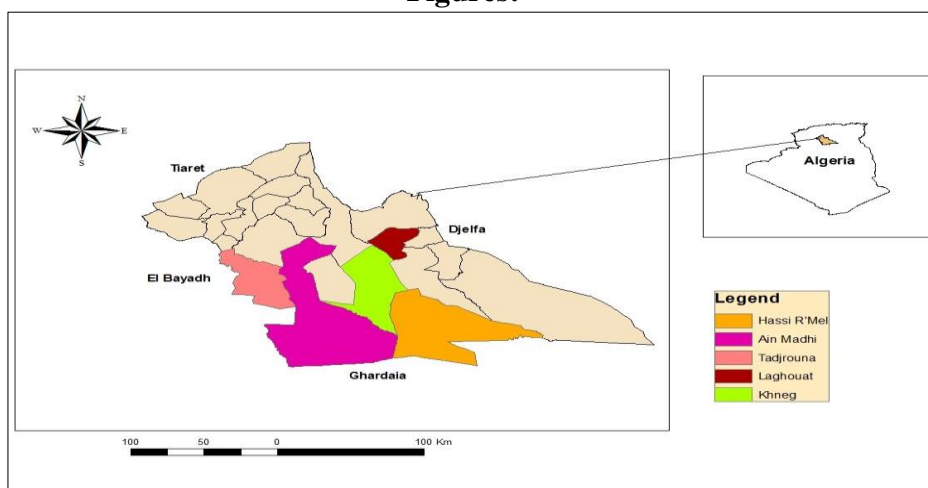


Figure 1: Study area

A



C

B



D

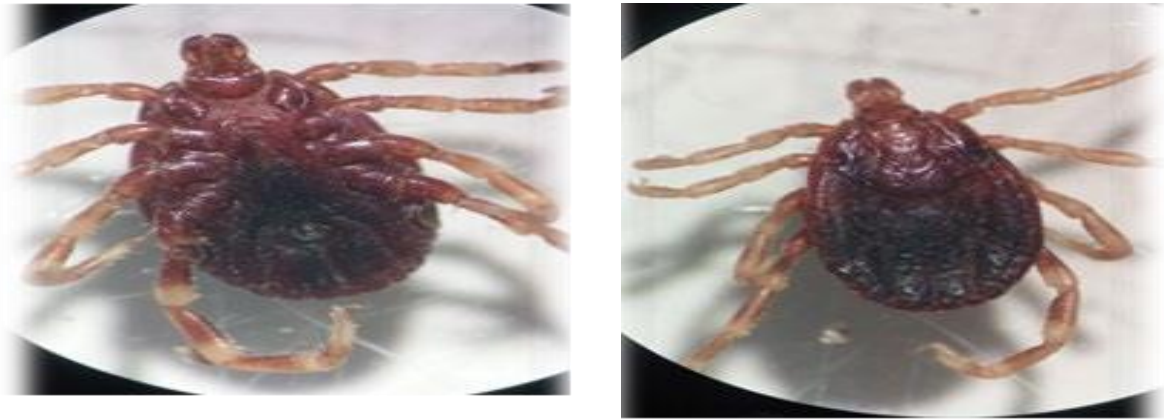


Figure 2: A-D. *Hyalomma dromedarii* A: Male dorsalface, B: Male ventral face C: Female dorsal face,D: Female ventral face



A

B



C

Figure 3: *Hyalomma impeltatum* A: Male dorsal face, B: Male ventral faceC: Female dorsal face Female

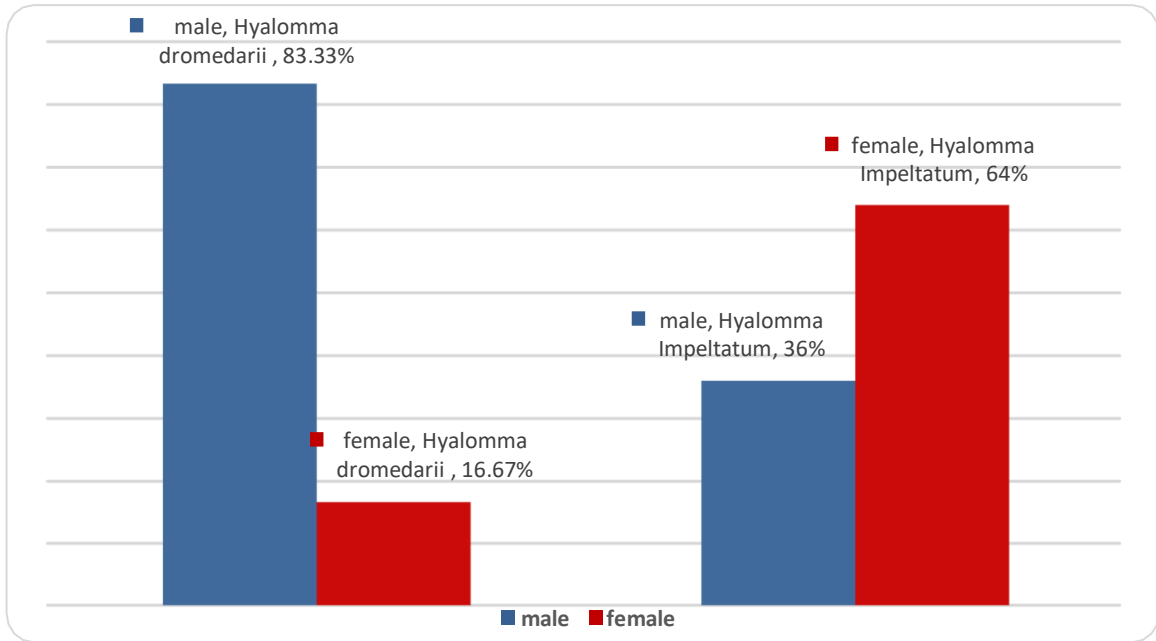


Figure 4: number of ticks according to their species.

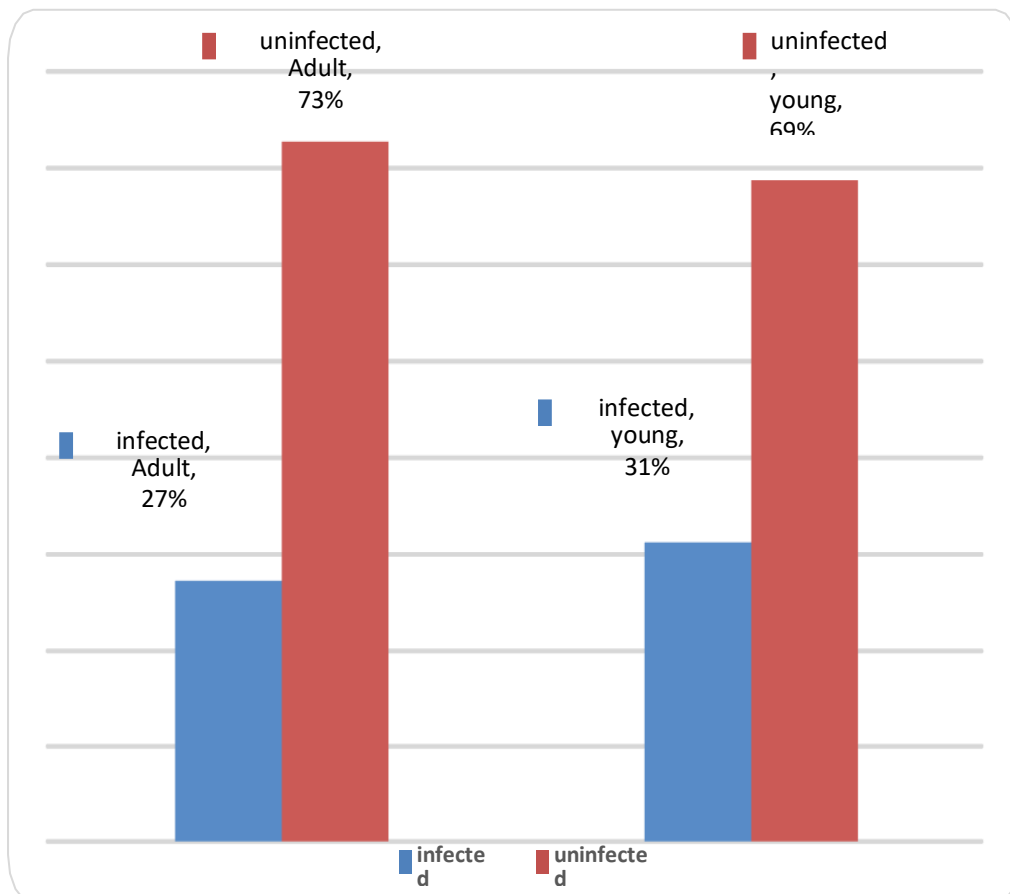


Figure 5: Prevalence of ectoparasites by age of camels.

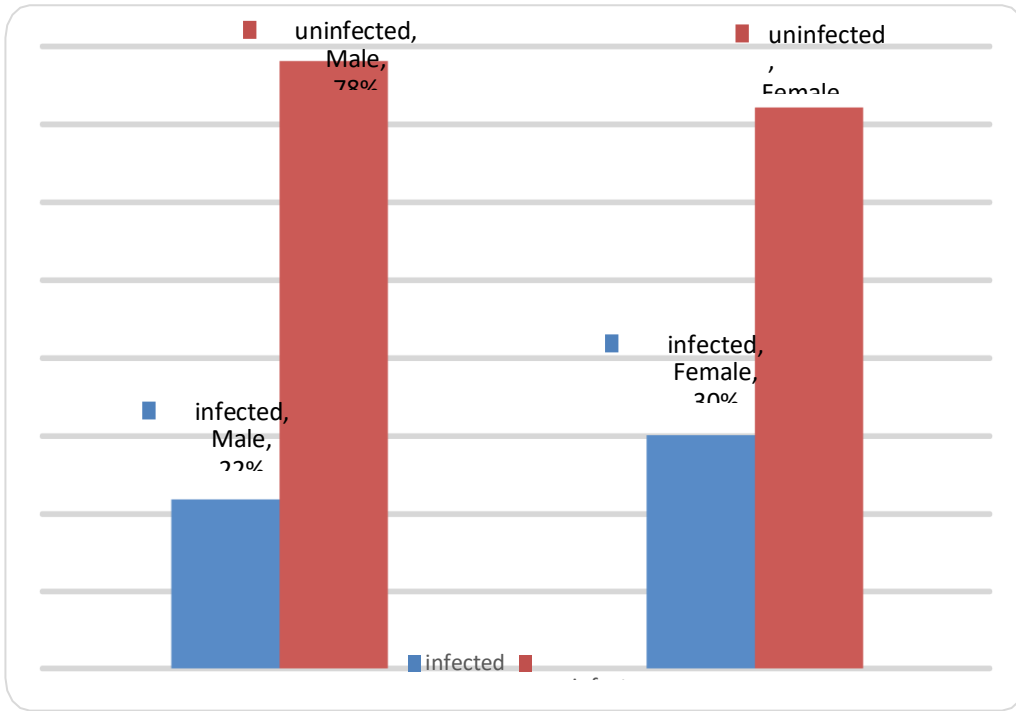


Figure 6: Prevalence of ectoparasites by sex of camels.

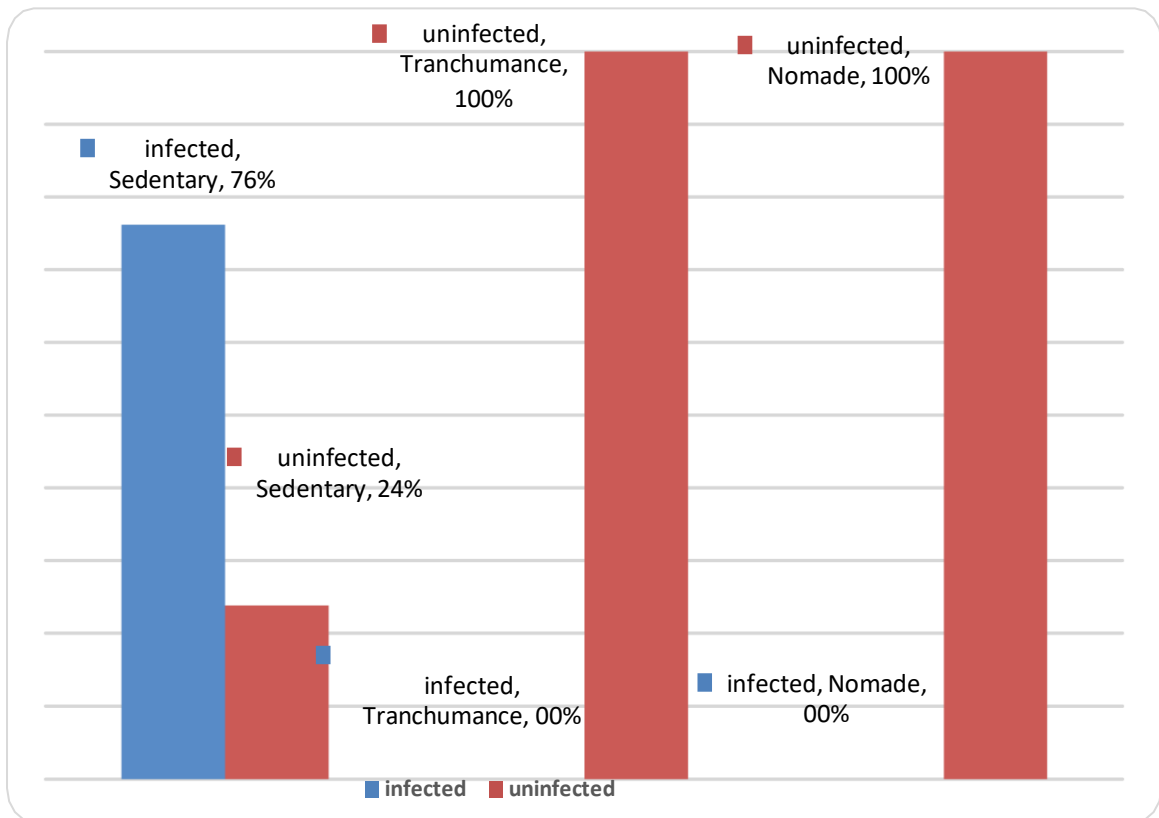


Figure 7: Prevalence of ectoparasites by type of breeding.

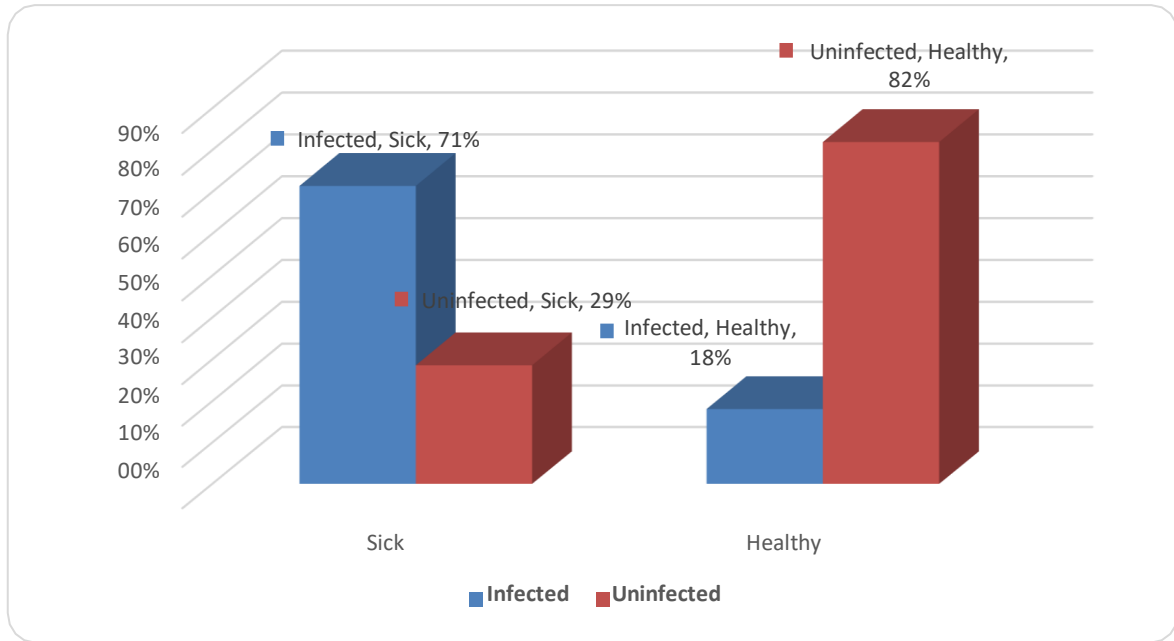


Figure 8: Prevalence of ectoparasites by clinical status.

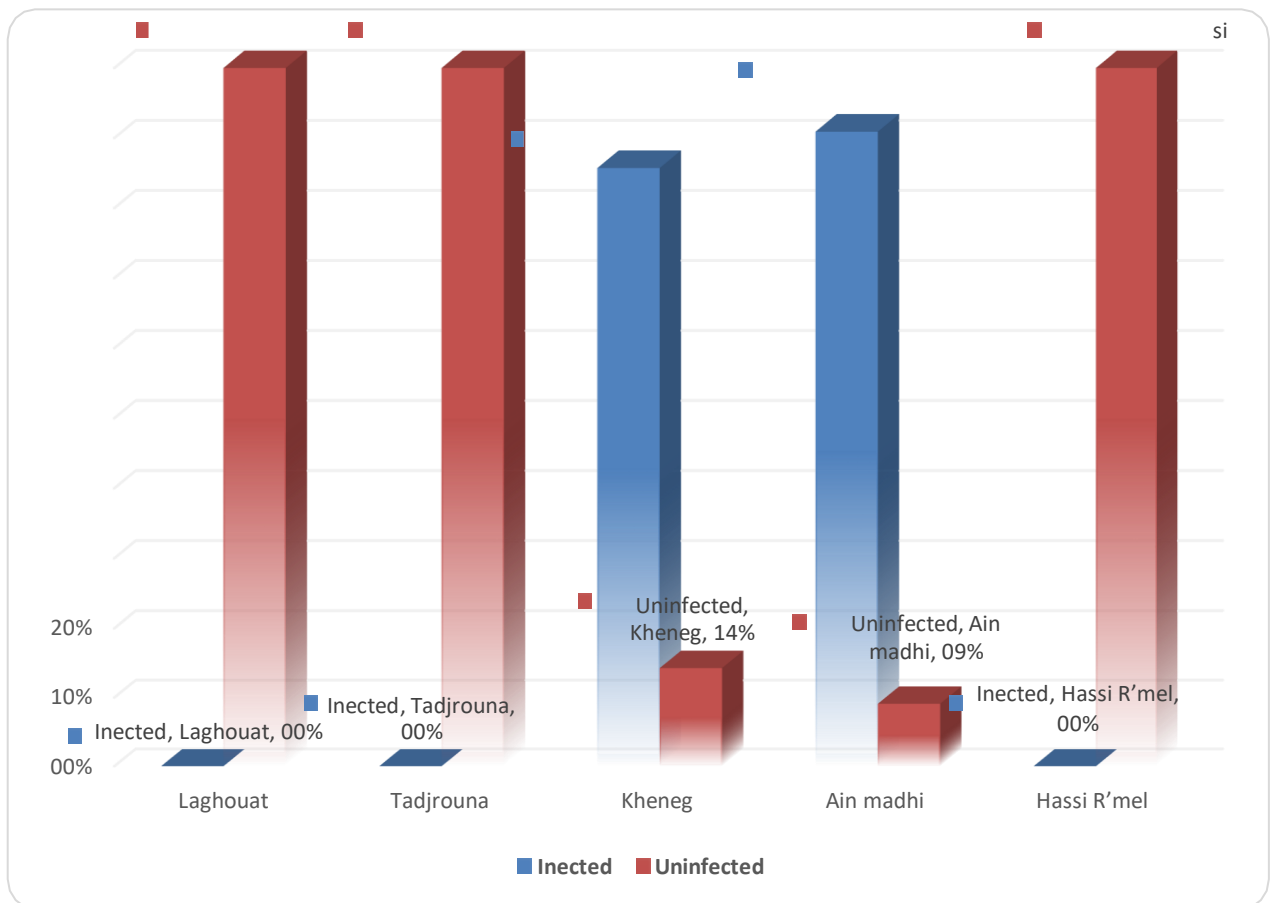


Figure 9: Prevalence of ectoparasites by study site

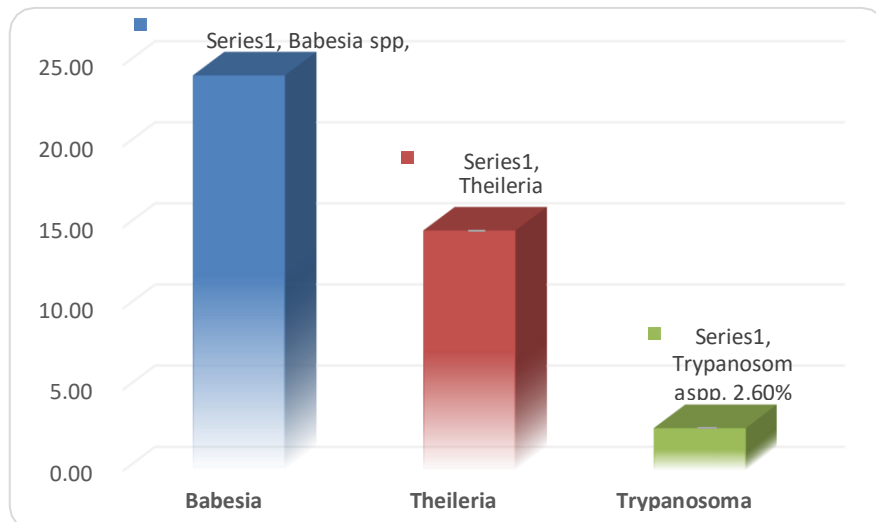


Figure 11: Prevalence of haemoparasites according to their species.

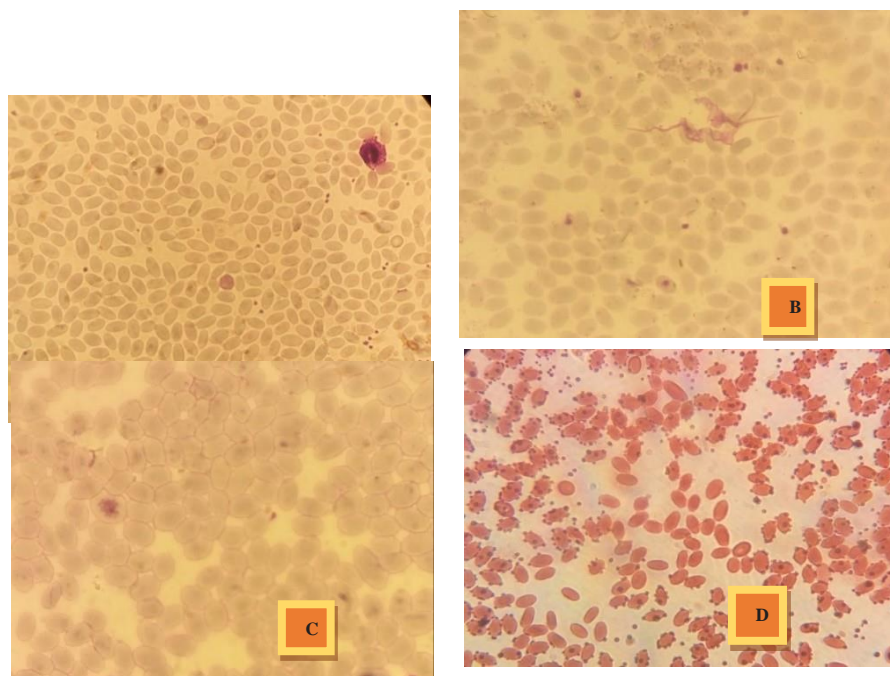


Figure 10: Parasite-infected blood smear

A. Holy Blood; B. *Trypanosoma spp*; C. *Babesia spp*; D. *Theileria spp*.

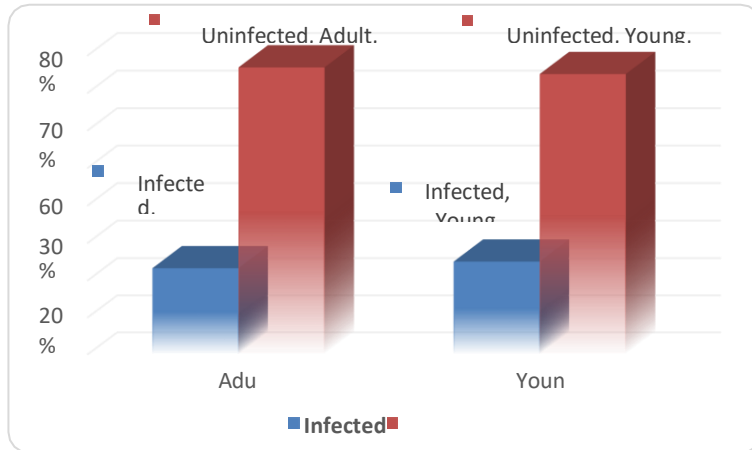


Figure12: Prevalence of haemoparasites by age of camels.

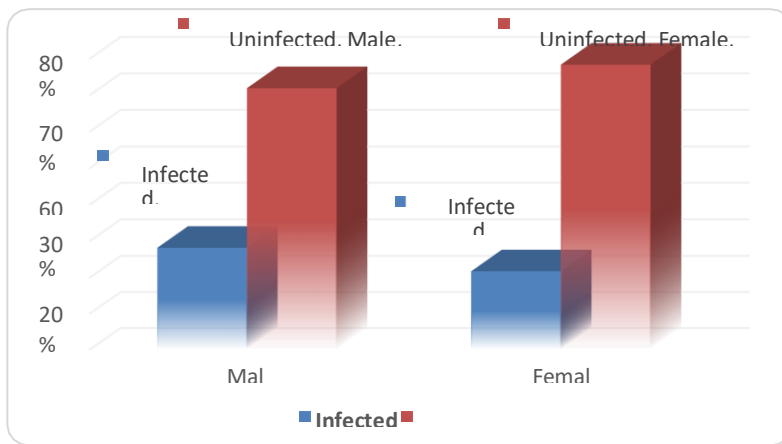


Figure 13: Prevalence of haemoparasite by sex.

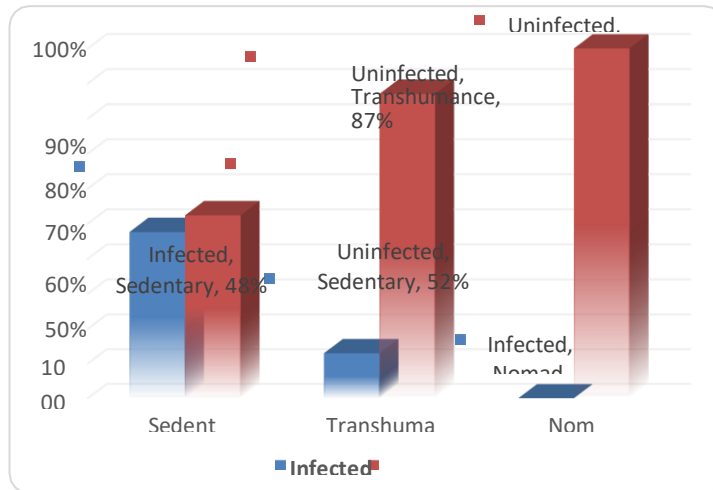


Figure 14: Prevalence of haemoparasites by breeding method.

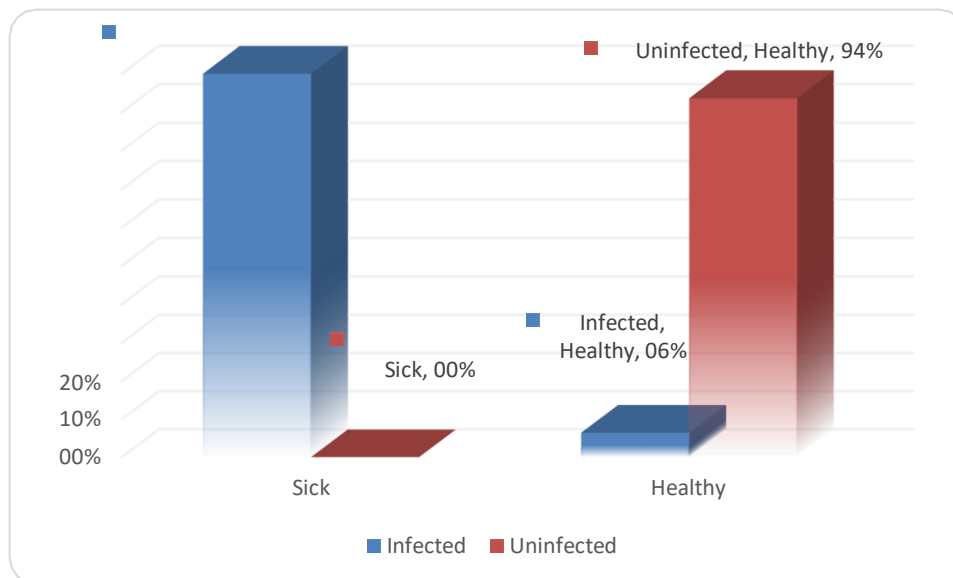


Figure 15: Prevalence of haemoparasite by clinical status.

	Infected, Sick, 100%	
100%		
90%		
80%		
70%		
60%		
50%		
40%		
30%		Uninfected,

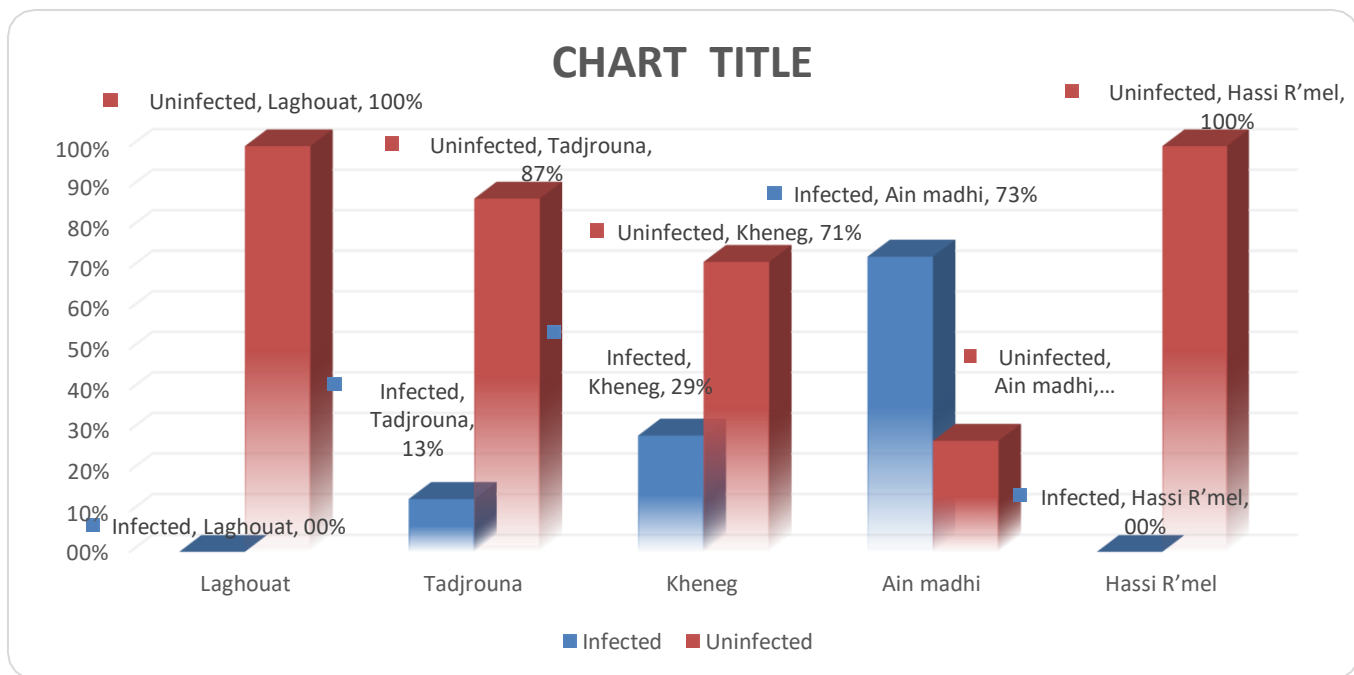


Figure 16: Prevalence of haemoparasites by study site.

Tables:

Table 1: The characteristics of the farms

Criteria	Variable	Number of farms	%
Localities	Laghouat	1	12.5%
	Ain Madhi	2	25%
	Tadjrouna	2	25%
	Kheneg	2	25%
	Hassi R'Mel	1	12.5%
Breedingmethod	Transhumance	1	12.5%
	Nomad	1	12.5%
	Sedentary	6	75%
Feeding type	Barley flour	1	12.5%
	Plants	1	12.5%
	Mixed	6	75%
	Milk	4	50%
Aim breeding	Milk and meat	1	12.5%
	Milk and fur	2	25%
Vaccination	Yes	2	25%
	No	6	75%

Table 2: Animals characteristics

Criteria	Variable	Laghouat	Ain Madhi	Tadjrouna	Kheneg	Hassi R'Mel	Total number	%
Sex	Female	5	19	39	9	10	82	71.3%
	Male	1	3	15	5	9	33	28.7 %
Age	Young	5	3	0	2	6	16	13.91%
	Adult	1	19	54	12	13	99	86.09%
Clinical Status	Healthy	6	6	48	10	19	94	81.74%
	Sick	0	16	6	4	0	21	18.26%
Type	Ectoparasite	0	20	0	12	0	32	27.82%
	Haemoparasite	6	22	54	14	19	115	100%

Table 3: Association of ectoparasite genera in the examined camels.

Association of parasites	N	%
<i>Hyalomma dromedarii</i>	22	19.25 %
<i>Hyalomma dromedarii</i> + <i>Hyalomma impeltatum</i>	10	8.75 %

Table 4: Association of haemoparasite genera in examined camels.

Association of parasites	N	%
<i>(Babesia spp)</i>	9	7.82 %
<i>(Babesia spp+Theileria spp)</i>	16	13.91 %
<i>(Babesia spp+ Trypanosoma spp)</i>	2	1,74 %
<i>(Babesia spp + Trypanosoma spp+ Theileria spp)</i>	1	0,87 %

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