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Memory

Towards the Master's degree

Stream: Biological Sciences

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THEME

Contribution to the study of ectoparasites and haemoparasites infesting camels in Laghouat

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Dedication

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

Praise is to God, who is done with the good grace of the righteous.

No other people left what they gave me. My father did everything.

To whoever Sandi and my insecure sailor have supported me and my constant cheerleaders when they call me by his name Happiest and pride me that I am his daughter and fruitful from Wright reflects my success and joy in his eyes, I can't tell you thank you that it is saying only at the ends and I always see myself at the beginning

To who made himself a burning candle to light us a path of success

I ask God to mercy you with his mercy, which has expanded everything.

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If you live with joy, started with your mother.

My girlfriend, my mother, my first teacher, taught me the meaning of tenderness and giving.

The meaning of patience, strength and love of those whose prayers and satisfaction were the secret to my success in my career.

To my beautiful pleasure Maryam Taibi

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

(أَفَلَا يَنظُرُونَ إِلَى الْإِبِلِ كَيْفَ خُلِقَتْ * وَإِلَى السَّمَاءِ كَيْفَ رُفِعَتْ * وَإِلَى الْجِبَالِ كَيْفَ نُصِبَتْ * وَإِلَى الْأَرْضِ كَيْفَ سُطِحَتْ * فَذَكِّرْ إِنَّمَا أَنتَ مُذَكِّرٌ * لَّسْتَ عَلَيْهِم بِمُصَيْطِرٍ)

صدق الله العظيم

Abstract

The objective of this work is to study the prevalence of ectoparasites and haemoparasites in camels in the Laghouat region. For this, a seven-month study (from December 2022 to June 2023) was carried out on a sample of 115 camels. We used blood smear methods to look for Haemoparasites. The results showed an overall infestation rate of 33.9%. This study showed the presence of the following parasites: *Trypanosoma spp* (2.6%), *Babesia spp*. (24.3%), *Theileria spp* (14.8%), and the ectoparasites which are: *Hyalomma dromedarii* (32%) and *Hyalomma impeltatum* (9%).

The statistical treatment regarding the infestation by haemoparasites showed a significant influence ($p = 0.002$) ($p = 0.02$) and ($p = 0.07$), while other parameters (age, sex, breeding method, clinical judgment) had no significant influence ($p > 0.05$).

Key words: Camels, Laghouat, blood smear, ectoparasite, haemoparasite.

Résumé

L'objectif de ces travaux est d'étudier la prévalence des ectoparasites et des hémoparasites chez les camelins dans la région de Laghouat. Pour cela, une étude de sept mois (de décembre 2022 à juin 2023) a été menée sur un échantillon de 115 camelins. Nous avons utilisé des méthodes de frottis sanguin pour rechercher les hémiptères. Les résultats ont montré un taux d'infestation global de 59%. Cette étude a montré la présence des parasites suivants : *Trypanosoma spp*. (2.6%), *Babesia spp*. (24.3 %), *Theileria spp.* (14.8%), et les ectoparasites qui sont : *Hyalomma dromedarii* (32%) et *Hyalomma impeltatum* (9%).

Le traitement statistique concernant l'infestation par les hémiparasites et ectoparasites a montré une influence significative ($p = 0,002$) sur la prévalence, ($p = 0,02$) et ($p = 0,07$), tandis que d'autres paramètres (âge, sexe, mode d'élevage, état clinique) n'ont eu aucune influence significative ($p > 0,05$).

Mots clés : Chameaux, Laghouat, frottis sanguin, ectoparasite, hémiparasite.

الملخص

الهدف من هذا العمل هو دراسة مدى انتشار الطفيليات الخارجية والطفيليات الدموية في الإبل في منطقة الأغواط. ولهذا أجريت دراسة لمدة سبعة أشهر (من ديسمبر 2022 إلى يونيو 2023) على عينة مكونة من 115 جملا. استخدمنا طرق مسحة الدم للبحث عن طفيليات الدم. وأظهرت النتائج أن نسبة الإصابة الإجمالية بلغت 33.9%. أظهرت هذه الدراسة وجود الطفيليات التالية: (*Trypanosoma spp.* (2.6 %), *Babesia spp.* (24.3 %), *Theileria spp.* (14.8%

والطفيليات الخارجية وهي: (*Hyalomma dromedarii* (32%)، و (*Hyalomma impeltatum* (9%).

أظهرت المعالجة الإحصائية بخصوص الإصابة بالطفيليات الدموية تأثيراً معنوياً (p= 0.002) (p= 0.02) ، في حين أن العوامل الأخرى (العمر، الجنس، طريقة التربية، الحالة السريرية لم يكن لها تأثير كبير (p> 0.05).

الكلمات المفتاحية: الإبل، الأغواط، مسحة الدم، طفيل خارجي، طفيل داخلي.

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List of abbreviations

ADS: Agricultural Services Directorate.

CIRAD: Centre for International Cooperation in Agricultural Research for Development.

F.A.O: Food and Agriculture Organization.

FAOSTAT : Food and Agriculture Organisation Statistique.

HD: *Hyalomma dromedarii.*

HI: *Hyalomma impeltatum.*

P : Prevalence.

SPSS: Statistical Package for the Social Sciences.

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Introduction

Introduction

For centuries, the camel has been a very important animal in desert areas due to its ability to withstand very harsh conditions (high temperature and drought), to provide milk, meat, its use as a mean of transport and its ability to digest poor forage compared to other domestic ruminants. The camel is present in 35 countries around the globe, 18 of which are African nation's .In Algeria, the camel population is estimated at 140,000individuals, but are considered good source of milk and meat to nomadic and urban habitants, and are used for other purposes such as transportation **(Saidi et al., 2021),**From the last research in the region of our study we mention that Laghouat has 2,812 head **(DSA, 2023).**

The dromedary shows remarkable adaptability allowing it to make the most of the available resources of the Saharan ecosystems; this is the animal without which the great nomadic civilizations could never have existed, It can survive, reproduce and even produce in an environment resource poor due to the hump, which is a considerable part of fat reserves and has the advantage of being easily visible. The survival of this animal, moreover, like all domestic animals, is subject to the action of many intrinsic factors or extrinsic factors **(Bouhous et al., 2008).**In Algeria, it seems that there is only one camel species: the dromedary (*Camelus dromedarius*); it has always been a part of the socio-economic landscape .Unfortunately, the dromedary remains a poorly exploited wealth, it returns low performances because it is left to itself or conducted in a traditional way based on a limited level of technicality and exceeded **(F.A.O., 2020).**

Camels are susceptible to infection by multiple parasitic diseases resulting in significant economic losses related to reduced productivity and performance, including mortality in severe cases. Camel farming suffers from many debilitating parasitic diseases, including vector and blood-borne infections such as babesiosis, theiliriosis, rickettsiosis and trypanosomisas **(Abou El-Naga et al., 2016).**

Unfortunately, on natural ranges. From which they derive most of their food these livestock are subjected to many constraints these include health problems that affect growth, especially in arid areas dedicated to camel farming, which require extensive prevention and treatment measures. Among these pathologies, external parasitoses of haematophage arthropods which are one of the

main concerns of camel breeders. The most frequently cited are sarcoptic scabies and ticks, which are the leading prevalence of dromedary disease in the country **(Abou El-Naga et al., 2016).**

Ticks pose serious animal and human health problems (diseases zoonotic), and when present in large numbers, pose economic losses for the owners of the animals. On the one hand, by the direct (harmful) affects they cause and the indirect by their ability to transmit a significant number of pathogens (viruses, bacteria and protozoa). They are the leading vectors of one of the world's pathologies: Babesiosis; Anaplasmosis; Babilism; Tick-borne Encephalitis and Lyme Borreliosis **(Adamou A. 2009).**

In this sense, this study aims to research and identify ectoparasites and haemoparasites in dromedaries in the Laghouat region during the period of December 2022 to June 2023, in order to assess their prevalence and determine the effect of certain factors (sex, age, race and place of residence) on infestation by these parasites.

This work is structured around four chapters:

The first chapter includes general information on dromedaries concerning classification, diet, breeds, geographical distribution, etc. The second chapter includes general information on ectoparasites and haemoparasites concerning classification, morphology, etc. The third chapter includes the presentation of study sites, equipment and methods used in the field and laboratory. The fourth chapter includes the results and discussion. Finally, we will conclude with a general conclusion that makes it possible to make a synthesis of the various results previously described and the expected perspectives in terms of development than research.

Bibliographic synthesis

Chapter I: Bibliographic data on camels

I.1. Presentation of camels:

Dromedaries or camels are mammals, from the family Camelids to the suborder Tylopoda or digitigrade ruminants (*Tylopoda*). They are Artiodactyls from arid regions. They have a 3-compartment stomach and they ruminate. They digest roughage well **(Christian, 2009).** This family has 3 genera (*Camelus, Lama and Vicugna*). The genus *Camelus* has two species: *Camelus dromedarius* (1-humped dromedary), and *Camelus bactrianus* (2-humped Bactrian camel). The other genus *Lama*, the genus Camelus occupies the desert regions of the Old World while the genus *Lama* is specific to the high deserts of the New World where it gave rise to 3 species: Lama in the strict sense (*Lama glama*), *Lama guanicoe* (*guanaco*) and *Lama pacos* (the alpaca), Finally, the genus *Vicugna* or *Vigugna* alone Non-domestic camelid **(CIRAD, 1999).**

Camels are known to play an important role in the lives of people living in arid regions. Because of their versatile role (milk, meat, transport, leisure). And their unique ability to adapt to harsh conditions **(Ali et *al,* 2019).**

Photo01: Bactrian camel ***(Mayer, 2009).***

Photo02: *Camelus dromedarius (***Original photo, 2023).**

I .2.Taxonomy of the dromedary

The name "dromedary" is given to the species *Camelus dromedarius.*

Table 01: Classification of the dromedary ***(Wardeh, 1989; Chahma, 1996).***

Animalia
Mammalia
Placentaires
Artiodactyla
Tylopodas
Camelidae
Camelinaes
Camelus
Camelus dromedarius

I.3. Camel breeds and their main characteristics

The camel populations belong to two large genetic groups: the Chaâmbi and the Targui (Méharie) which nevertheless have subtypes: Reguibi, Sahraoui, Camel of Aftouh, Adjer, Ait Kebbach, Ouled Sidi Echikh and Camel of the steppe. The dromedary is used for different purposes: production (meat, milk, hair, and skins), transport, work (ploughing) and leisure tourism **(FAO, 2003).**

I.3.1The Chaambi

Medium-line animal, strong, with medium-long dark coat, also strongly crossed with Arabian blood. It is an animal well adapted to both stone and sand. It is found in the highlands north of the great western erg (South Oranais). Its breeding is currently in decline and has been replaced by the Sahrawi **(FAO, 2003).**

Photo 03: Camel Chaambi***(original photo, 2022).***

I.3.2.The Saharawi

It is the result of crossing the Chaâmbi breed with that of Ouled Sidi Cheikh. A robust medium-line animal, with dark coat, mid-length, it is an excellent troopthat lives from the great western erg to the center of the Sahara **(Fao, 2003).**

Photo 04: Camel Saharaoui***(International Centre, 2019).***

I.3.3.The Berberi

Strong fine animal, with a muscular hind hand, encountered especially between the Saharan and Tellian zones. It is very close to Chaâmbi and OuledSidiCheikh**(Fao, 2003).**

Photo 05: Camel Berberi***(Ghadeir, 2007)***

I.3.4.The Camel of the Steppe

It is a common dromedary, small, reviling. He's a bad carrier. It is used for close nomadic hens. It is found in the confines of the Sahara and especially at the limit of the steppe and the Sahara. This type is in decline **(Fao, 2003).**

Photo 06 : The Camel of the Steppe ***(Babelhadj et al, 2021).***

I.3.5.The Targui (Race of the Northern Tuareg)

The dromedary's targuis are animals accustomed as well to the rough escarpments of Tassili and the Central Massif of Hoggar, as to the sands. It is a fine animal with very muscular limbs. The bump is small and thrown back. The tail is also small and the soles of the feet are fine. It is an excellent for border patrols. He has a pale or piebald coat, close-cropped hair and very fine skin. It is a saddle animal par excellence, often sought in the Sahara as a breeder. It is found mainly in the Hoggar and its surroundings as well as in the central Sahara **(FAO, 2003).**

Photo 07: CamelTargui***(International Centre, 2019).***

I.3.6. Ouled Sidi Cheikh

It is a saddle animal. It is found in the highlands of the great Western ERG.

I.3.7.The AitKhebbach

Is a bat animal. It is found in the South-West area **(Ben Aissa, 1989).**

Photo 08: CamelAitKhebbach***(Ghadeir, 2007).***

I.3.8.The Ajjer

Good walker and carrier. Is found in the Tassili of Ajjer**(Ben Aissa, 1989).**

Photo 09: Camel Ajjer***(Meghelli et Kaouadji, 2016).***

I.3.9.The Reguibi

Very good mehari. He went back to Western Sahara, South Orannais (Bechar, Tindouf).

His cradle: Oum el Assel (Reguibet) **(Ben Aissa, 1989).**

Photo 10 : CamelReguibi***(Meghelli et Kaouadji, 2016).***

I.3.10.The Camel of Aftouh

Used as draft and bat animals. It is also found in the Reguibet region (Tindouf, Bechar) **(Ben Aissa, 1989).**

Photo 11 : The Camel of Aftouh ***(Rahil, 2015).***

Figure 01: The worldwide distribution of large camels (*Dromedaries*) ***(Faye and Bonnet, 2012).***

I.4.Breedingmethods

In broad terms, there are two breeding methods: extensive breeding (commonly followed, practiced in rangelands and vast areas and which is based on natural vegetation) and intensive breeding (limited and which is based on the use of food supplements). At the limit of these two modes is added another breeding system, the semi-intensive mode.

A.Extensivebreeding

It generally includes the following breeding systems:

- **Nomadism:** Camel breeding is often associated with nomadism, an ancient method, which results in moving over great distances in search of pasture and 'water. The nomad has adapted to this rhythm of life, moving with his animal where grass and water are available, across vast routes. According to (**El Amin, 1979)**, nomadic tribes can travel more than a thousand kilometers in a single season, but the actual distances traveled depend on the abundance of water and pasture, these systems suit the way in which feeds the dromedary.
- **Semi-nomadism:** here too, food is ensured, for a good part of the year, by irregular movements in search of grass and water. Unlike nomadism, herders have a "fixed habitat" attachment point; where herds spend part of the year (**Qaaro, 1997)**.
- **Sedentary:** this type of farming bases the diet on resources located near the

fixed habitat, and on agricultural products. Herds are generally small **(Qaaro, 1997)**.
- **Transhumance:** It is the cyclic seasonal movement of herds, which is synchronized with the rains, for the ex-temporary **(MAP, 1986)**. The transhumant system is extensive based on the almost exclusive use of rangeland resources and herds are often entrusted to shepherds. The shepherd's know-how is based on tradition, which is an advantage in terms of knowledge of the use of the natural environment, but which is insufficient in terms of animal husbandry. The problems are therefore linked to the insufficiency or the decrease in the seasonal quality of fodder availability, or to the lack of monitoring of the herd, in terms of food, reproduction and health **(Ould Ahmed, 2009)**.

B.Semi-intensivefarming

- In semi-intensive farming, livestock are kept in stalls **(Correa, 2006).** Throughout the dry season, the camel herds, consisting solely of dairy cows and which receive a ration in the morning before leaving in search of pastures in the outlying areas of the city. They return very early in the afternoon and receive water and food supplements consisting of groundnut cake, bran, rice, wheat, etc. **(Ould Soule, 2003; Correra, 2006).** During the rainy season, food is almost exclusively based onnaturalpastures.
- Dairy production is better from a qualitative and quantitative point of view during the rainy season because the feed is more balanced. They also vary according to the stage of lactation from 3 to7 litres/day (i.e. an average of4.5 litres/day). This has earned dromedaries to be privileged to the detriment of other domestic species and, moreover, to benefit from a renewed interest on the part of senior officials, businessmen, large traders who invest in the breeding of camels, means of savings and indisputable prestige. They entrust their herds to salaried shepherds and they also have recourse to health services (prophylaxis, veterinary care, vaccines, etc.) **(Correra, 2006).**

The semi-intensive camel system has drawbacks linked to the irrational exploitation of this animal species. In fact, the owners buy females at the end of gestation or at the start of lactation to make their production profitable. When the latter have dried up, they are put up for sale with the young to renew the herds. This represents a potential loss for the breeding sector insofar as these females able to reproduce generally end up in butchery before the end of their reproductive life.

This constitutes a major problem for the reproduction and the survival of the species **(Belkacemi and Souaker, 2017).**

C.Intensivebreeding

In these senses, Ben Aissa in 1989 noted the evolution of a new mode of breeding or rather exploitation of dromedaries. This is fattening in ranges delimited in view of slaughter. The

"operators" organize themselves to acquire camels in the areas of production and transport them by truck to fattening areas where they are then slaughtered. This system seems to have developed in recent years, following the increase in prices red meats.

The use of intensive systems is also remarkable in racing animal farms. The dromedary is capable of yielding to the demands of "modernity" in animal husbandry and undergoing an intensification of its production to meet the growing demands of urban populations in desert and semi-desert areas. It also benefits from a favorable prejudice due to its image as an animal of the great outdoors, even if the intensive farming method brings it closer and closer to other species. This ability to meet the food challenges of the modern world gives it a promising place in the animal production of tomorrow **(Belkacemi and Souaker, 2017).**

I.5.Morphology

The dromedary is very distinct from other domestic animals, in particular, by the presence of a long neck, hump and calluses. The limbs are powerful; more than 65% of body weight is supported by the hind limbs **(Wilson, 1984).**

The head is wide, the neck wide and thin, the sternal pad holding the abdomen slightly above the ground, the dromedary has no horns, the ears are small, the eyes wide and protruding, the long nostrils can be reformed for needs of the animal, the upper lip is divided, melted, hairy, extensible and very sensitive, the lower lip is wide and pendulous. The animal has glands behind its head which are used for perspiration **(Ould Ahmed, 2009).**

The skin is supple covered with hair. The lengthening is often at the shoulders and hump, the hair color is usually brown varying from dark chocolate to almost black to red or rusty tawny to almost white in a few types. The female has four quarters at the level of the udder, the male's testicles are positioned high behind the thighs (as in cats and dogs) and the beginning of the sheath is directed backwards. These morphological and anatomical particularities could explain the dromedary's ability to adapt to a desert environment than other domestic herbivores **(Kayouli et *al*, 1995).**

I.6.Behaviorofthedromedary

The dromedary lives in herds made up of small groups of females and juveniles led by a dominant adult. The dromedary can walk at a pace of 4 to 7 km/h, between 40 and 50 km per day, sometimes for several weeks. During his race, he ambles:

He advances both legs on the same side, and when he squats, it is said of him that he is stalling. When it emits sounds, it blathers **(Meghelli and Kaouadji, 2016).**

I.7.Feeding

The dromedary is accustomed to the vegetation of dry areas, it uses ligneous resources

which may be more abundant than herbaceous resources on the margins of the desert. He can have easy access to other resources from agriculture (broken or bran of rice or wheat, barley, brewers' spent grains, etc.) or commercial supplements **(Driot, 2009)**

I.8.Reproduction

The reproduction period is linked to environmental conditions: lower temperatures, abundant rains and quality food resources **(Faye et *al,* 1997).**

The female gives birth every two years to a single young after a gestation varying between 12 and 14 months. The camel is able to walk a few hours later. Her mother nurses her for a year. Females reach sexual maturity around three years. The male is only bred between the ages of 6 and 12 **(Zarrouk et *al,* 2003).**

I.9. Socio-economic roles of dromedary

The dromedary is, of all the domestic animals, the most domesticated in the environments with desert and sub-network, tropical and subtropical climates **(Charnot 1959).**

This can be explained by its ability to resist the lack of water on the one hand, and by the primary roles that this animal plays for the populations of the areas concerned on the other hand **(Chatt, 2013).**For thousands of years, he has rendered many services to man, especially to the nomads who exploit him for his work **(Dehane, 2010),** his fat and milk and especially his meat, the dromedary provides valuable food resources **(Hamad, 2009).**By transporting the material, it allows man to save himself and last in desert environments **(Dehane, 2010).**

I. 9.1. Camel meat

This meat is eaten cooked, usually boiled, boneless, salted and dried. It is quite similar to beef in its overall chemical composition, taste characteristics and nutritional value **(Adamou, 2009; Faye, 1997; Lasnami, 1986).**

Currently, despite the increase in its price, this meat is even more in demand, given its nutritional value, in this sense **(Hamad, 2009)** reported that camel meat is a food of choice, its rich water and protein of high biological value makes it an indispensable food for a balanced diet. However, the production of camel meat rose from 3900 tonnes in 2000 to 4180 tonnes in 2010, which enabled Algeria to be 15th in the world in 2011 with 5190 tonnes of camel meat produced **(FAO, 2013).**

I.9.2. Camel milk

The camel is never intended for slaughter, its milk is a food sourceimportant, **(Chethouna, 2011)** believes that camel milk has long been the main food resource for nomads. Traditionally, breeders serve camel milk as a food of hospitality, **(Adamou and Boudjenah, 2012)** have reported that selling camel milk is an offence to the rules of nomadic hospitality in different parts of the country.

However, in recent years, peri-urban rearing in the Saharan regions has created points of sale for camel milk fixed near national roads. Surveys conducted by **(Ceneap and Cdars, 2015)** have shown that the sale of camel milk is beginning to be practiced more and more in the major urban centers of the Sahara to reach the large cities of the north of the country. But the fact remains that this milk production still seems insufficient given the growing demand of consumers from other regions of the country attracted by its good nutritional quality **(Medjour, 2014)** and its anti-infectious, anti-cancerous, anti-ant diabetic and more generally as a restorative in convalescent patients **(Kanaspayeva, 2007).**

1.9.3. Dromedary hair

The best hair is harvested from young camels, this is affirmed by**(Slimani, 2015)** by declaring that the fleece of shamelons is the most sought after, in fact, in the Saharan wilayas, apart from the wilaya of Tamanrasset, dromedaries are mowed from their first year of age and this during the spring and summer **(Ceneap and Cdars, 2015).**

Dromedary hair is enhanced by the know-how of Saharan women who make the most famous Algerian ones: «Bernous» and «kachabia». According to **(Faye, 1997),** fleece is used alone or mixed for weaving clothing and is also used to make blankets, tents and carpets.

I.9.4. Camels skin

At the level of the Saharan wilayas, the average annual production ofcamel produced by controlled slaughtering is in clear increase, from 4545 during the 1960s to 27399 skins in 2012 and 29214 skins in 2014, but all this quantity is generally discarded **(Ceneap and Cdars, 2015).**Until now, this skin is considered to be waste, although **(Diallo, 1989)** indicated that camel leather is introduced into the manufacture of shoes and belts.

Generally, in all Saharan regions, the possession of camel herds represents a wealth, it remains a profitable socio-economic activity **(Lakhdari, 2012),** even if nowadays the role of the dromedary

as much as a transport animal has ceased completely, But the most important thing is to take into account that this animal is a main producer of red meat which contributes to the satisfaction of the needs of the Saharan and makes it possible to fill certain deficits especially when the supply of sheep becomes scarce. Besides this meat, milk is a product to be valued, according **to (Adamou and Boudjenah, 2012)**, the camel manages to produce it at a lower cost and under restrictive living conditions, and this observation encourages camel drivers to orient their dromedaries towards milk production.

In fact, several factors hinder the modernization of livestock systemsThese include the lack of economic interest in the sector, technical and social difficulties, and the lack of national, regional and international programs and strategies for dromedary development **(Sgheir,2005).**

Thus, the productive potential of the Algerian dromedary is largely underutilized; its current situation should be the subject of a real support for its full development starting with the simplest one, namely a real improvement in the conditions of feed and water **(Ceneap and Cdars 2015).**

I.10.Geographic distribution

I.10.1. Global membership and distribution

The global Camels population is confined to the desert and semi-arid belt of Africa and Asia. The dromedary is listed in 35 "originating" countries stretching from Senegal to India and from Kenya to Turkey. The Bactrian camel is only present in a narrow zone stretching from Turkey to China comprising barely ten countries **(CIRAD, 1999).**

Nearly 80% of the dromedary population is located in Africa where most of the numbers are concentrated in the countries of the Corn (Somalia, Sudan, Ethiopia, Kenya and Djibouti) which are home to about 60% of the world's Camelin *herd.* Somalia alone, with its 6 million dromedaries represents almost 50% of the African herd, which has earned it, without question, the title of "country of the camel" **(CIRAD, 1999).**

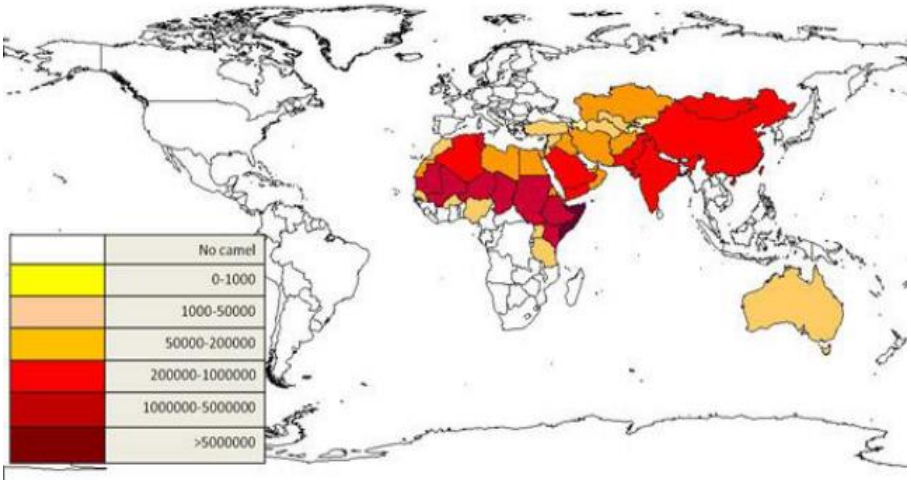

Figure 02: The worldwide distribution of large camels (*Dromedaries and Bactrians*)***(Faye and Bonnet, 2012).***

I.10.2. Workforce and distribution in Algeria

The Algerian camel population was evaluated this decade at 245,490 head. This has experienced a sharp regression, a consequence not only of often uncontrolled felling, clandestine exploitation, the decline of its traditional function, following the development of motorization and the sedentarization of the population of the steppe and the Sahara, but also the orientation and adaptation of breeding towards a new activity of meat production. This figure still places Algeria in 18th place in the world and 8th in the Arab world. The camel herd is distributed over three main breeding areas: the South East, the South West and the extreme South with respectively 52, 18 and 30% of the total number **(FAO, 2003).**

- The Southeast geographical area (91,450 head) comprises two zones:

A) The south-eastern zone proper which includes 2 Saharan regions (El Oued, Biskra) and 4 steppe regions (M'sila, Tebessa, Batna and Khenchela).

B) The central zone which includes 2 Saharan regions (Ouargla and Ghardaïa) and 2 steppe regions (Laghouat and Djelfa).

- The southwestern geographical area (82,220 heads) includes 3 Saharan regions (Béchar, Tindouf and the northern part of Adrar) and 2 steppe regions (Naama and El Bayadh).
- The extreme southern geographical area (94,940 heads) includes 3 Saharan regions (Tamenrasset, Illizi and the southern part of Adrar). **(FAO, 2003).**

Figure 03: Camel distribution areas in Algeria ***(Ben Aissa, 1989)***

I.11. Threat of camels in the arid environment

Livestock in desert states face several challenges, the most important being the lack of pasture, followed by water problems, and diseases such as scabies.

Digestive and respiratory diseases that pose a threat to livestock in Algeria **(Unknown, 2019).**

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Chapter II

General concepts on ectoparasites and haemoparasites of camel

II.1. Ectoparasites

According to **Heinz (2008),** ectoparasites are organisms that live outside of another organism. They are hooked or glued to the integuments or skin appendages of the host. Some can colonize body cavities of the host widely open to the surrounding environment (the oral and nasal cavity) **(Jérémy et al, 2004).** Arachnids and insects are most important in medical and veterinary entomology; either by the role of vector of pathogenic organisms, or as intermediate hosts **(Kabbout, 2017).**

They cause direct effects (irritation, skin lesion, blood loss) and indirect effects, including the transmission of pathogens that have a very significant impact on animal health **(Jérémy et al, 2004).**

II.1.1. Hard ticks (Arachnids of the Ixodidae family)

Ixodidae ticks are heamatophagous mites at all stages of their development. Are large temporary parasites (Guiguen, 2001). A distinction is made between a habitat during parasitic life (the specificity depends on the evolutionary stage) and another during free life (it is strongly linked to climatic conditions) **(Francois, 2008).** Tick infestations are quite common. The most commonly encountered ticks are: *Hyalomma dromedarii, H. rufipes, and Rhipicephalus pulchellus* **(Fassi and Fehri, 1987).** Ticks are of great economic importance because the bite of ticks reduces the value of the skin by 20 to 30%. In addition to their direct effect, ticks are important vectors of many pathogenic organisms (Bacteria, viruses, protozoa) than any other arthropod vector (**Dande, 2015; Selmi, 2020**). And considered one of the most important parasites among the factors affecting the health, productivity and performance of camels (**Kiros, 2014**). They transmit various diseases causing pathogens and causing blood loss, skin and udder damage on camels **(Megersa et al, 2012).** Their distribution throughout the world is very wide "Cosmopolitans" (**Perez-eid, 1998).**

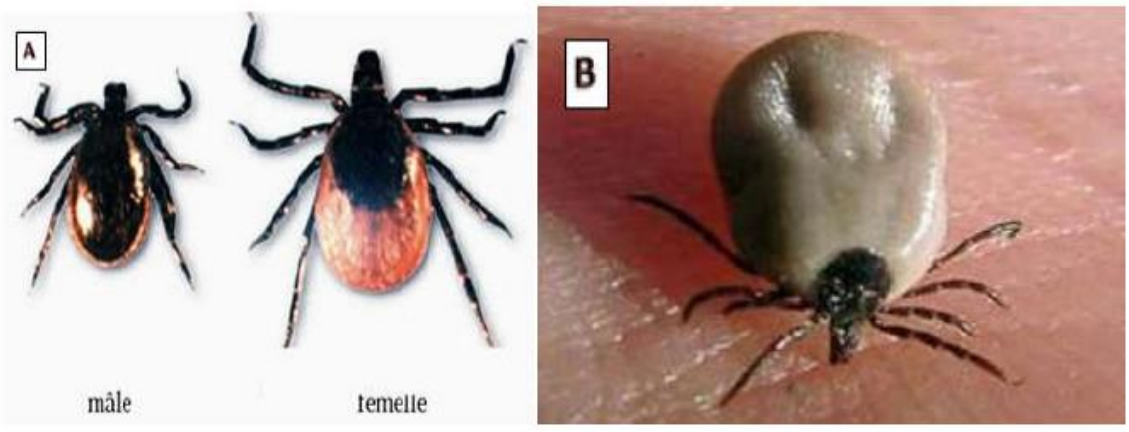


Photo12: Unfed male and female ticks (A); blood-engorged female tick (B)(Bourdeau, 2000; Francois, 2008*)*

II.2. Sarcoptid mites

Scabies caused by a small mite Sarcoptes scabiei var. camel. (Photo 13) The female, 0.3 mm long, digs galleries in the epidermis where she lays her eggs (Aubry et al, 2001). Transmission is by direct contact and the disease can affect the whole herd.

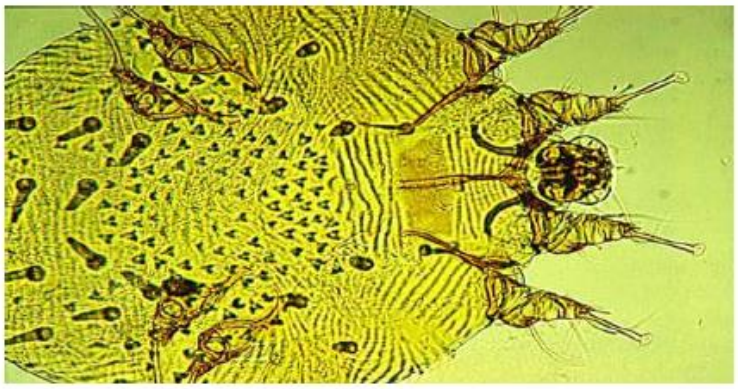


Photo13: Adult *Sarcoptes scabiei* (website 1).

The acute form is easily diagnosed (lesions of pruritus, depilation and hyperkeratosis at the level of the neck, the arms, the inguinal region, around the tail and the orbit)(photo 15), the sub-acute and chronic forms are much less so. Camel mange is transmissible to humans **(Fassi-fehri, 1987).** Reduction in production due to the *Sarcoptes scabiei* might as well as its contagious and potentially fatal nature in the absence of treatment **(Driot, 2009).**

Photo 14: Location of scabies on a male dromedary (**Arlette & Driot, 2009**).

II.1.3 Siphonapteran fleas

Fleas (siphonaptera = aphaniptera) are biting insects, wingless, small, laterally flattened and obligate parasites (in the adult state) of mammals and birds **(photo 16)** but not very specific to humans (Euzéby et al. al, 2005). Eggs and immature stages are found in the environment and are not parasitic; flea infestation is referred to as policies **(Deplaze et al, 2012).**

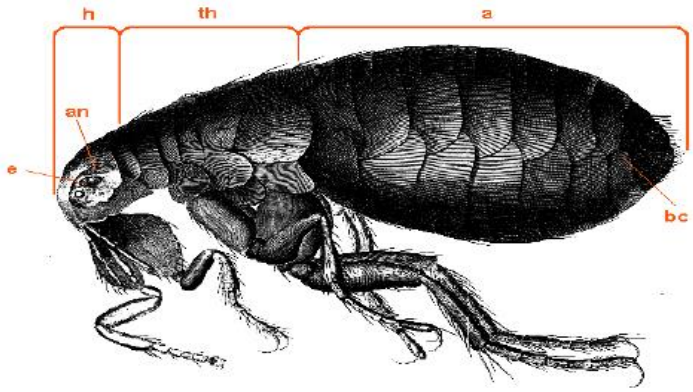


Photo 15: Schematic general morphology of an adult female flea *(Aubry et al, 2001)*

An abdomen; an antenna; be copulatory purse; o eye; h head; th thorax.

II.1.4 Sarcophagidae flies

Dipteral insect with squat shapes, from the Sarcophagidae family **(photo 16)**. Causes parasitosis since the mere presence of flies is in itself a nuisance. Except that they are vectors that transmit bacteria and protozoa. The larvae also bring nuisances called meiosis; wound meiosis (**Aubry et al., 2001**).

Photo 16 : Sarcophagidae flies *(Dehghani et al, 2014).*

II.4 Factors favoring the appearance of these parasites

- The season: this is the first extrinsic risk factor; heat and humidity favor the multiplication of most germs in the environment. And their transmission seems to be easy since during this dry period the number of water points decreases. This leads to an increase in contact between animals of the same herd and between animals of different origins at these water points **(Mjidou, 2018).**
- Hygienic conditions: Obstructed and poorly designed stalls, poor drainage favor the development of pathologies and the prevalence of germs **(Mjidou, 2018).**
- Primary contamination often appears in underprivileged environments and is transmitted to all classes of society. The life cycle of any ectoparasite depends on the environment and the climate (temperature / humidity) that it suits **(Aubry et al, 2001).**
- Malnutrition and deficiencies in vitamin A are favorable factors for the development of scabies **(Fassi-fehri, 1987).**

II.2. Haemoparasites in camels

The camel is an important multi-purpose animal and since ancient times has been used for the transport and production of milk, wool and meat in arid and semi-arid areas of the world. Although camels are hardy animals and can tolerate the harsh conditions of arid regions due to their unique adaptive physiological characteristics, these animals face a wide variety of diseases. Gastrointestinal and blood parasites are known to affect the health of camels, leading to anemia, emaciation and death in case of severe infection **(Abou El-Naga, et al. 2016)**

Trypanosomiasis is the most important pathogen and the most serious camel protozoan disease caused by T. evansi infecting a wide range of animals in tropical and subtropical regions of the world. Theileriosis is an important haemoparasitic disease of animals, caused by species of the genus Theileria has a wider distribution extending from North Africa to China. Piroplasmids belonging to the Babesia genera are suspected of infecting camels. These complex tick-borne APIs were generally considered to be highly specific for a given host species. Anaplasmosis is a ruminant arthropod-borne disease caused by species of the genus Anaplasma. **(Abou El-Naga, et al. 2016).**

II.2.1. Babesiosis and Theileriosis:

Babesiosis and theileriosis are widespread diseases around the world that influence many groups of farm animals. Most economic losses from these diseases are death of infected animals, low

milk productivity and cost of treatment. In addition to restriction of movement of animals for trade by quarantine laws. **(Al-mialy, et al.2018)**

Piroplasmosis is a protozoan parasitic blood disease of ticks, the main causes in camels are *Babesia caballi* and *Theileria equi, and* both transmitted by several species of ticks of the genus *Hyalomma, Rhipicephalus* and *Dermacentor.* From the genus *Haemaphysalis, Dermacentor and Rhipicephalus.* **(Al-mialy, et al.2018)**

Both diseases are complex ape parasites infecting a wide variety of organisms, carried by ticks. Mentioned diseases clinically characterized by fever followed by in appetence, depression, polypnea, weakness and reluctance to move. Hemoglobinuria is often present, anemia and jaundice develop especially in more prolonged and severe cases. In theileriosis, there is generalized swelling of the external lymph nodes **(Al-mialy, et al. 2018)**

There is a seasonal gap in the prevalence of clinical babesiosis and theileriosis, the greatest incidence occurs soon after the peak of the tick population, higher temperatures increase tick activity while humidity and precipitation has little effect. **(Al-mialy, et al.2018)**

II.2.2. Cameline trypanosomiasis:

Trypanosoma evansi trypanosomiasis is an infectious protozoan disease affecting a large number of mammals, with worldwide distribution. Its main mode of transmission is horizontal via mechanical vectors, essentially hematophagous biting insects such as tabanids. This trypanosome is quite pathogenic and virulent compared to other species. Although a few human cases have been reported, this disease is not considered a zoonosis **(Enwezor and Sackey, 2005).**

Trypanosoma evansi is the first trypanosome identified as a mammalian pathogen by Griffith Evans in equidae and camels in Dara Ismail Khan District in the Punjab region of India. It was first described by John Henry Steel in 1885 and was the subject of a second more detailed description in 1888 by Edouard-Gérard Balbiani **(Desquenes et** al, **2013)** (A) **.**In Algeria, *T. evansi* was first detected in 1903 in infected camels **(Benaissa et al. 2021).**

This often chronic condition is commonly called "surra" in Asia ("rotten" in Indi designating the state of the animal after a chronic infection) **(Fowler and *Bravo* 2010),** "zamboor" in the United Arab Emirates, "el debab" for “fly disease” in North Africa, “gufar” in Sudan, “mal de caderas” in Brazil, “derrengadera” in Venezuela or even “murrina” in Central America. It has more than 30 different names around the world **(Desquenes et** al, **2013)**.

Trypanosomosis only affects mammals. Its pathogenicity is nevertheless more pronounced in camelids, equines and carnivores **(Vergne, 2009).**

In Africa, dromedaries and camels are the main hosts of the parasite, although horses, cattle, goats, sheep, pigs and even dogs and cats can sometimes be infected. The antelope could be a reservoir **(Antoine-Moussiaux and Desmecht. 2008).**

A few human cases have been reported, notably in Egypt and India. Cattle, goats, vampire bats and capybaras are considered to be potential reservoirs of the parasite in these regions **(Birhanu et *al,* 2015).**

T. evansi trypanosomosis, for most of the family Tabanidae, genus *Tabanus.* Muscoda of the genus *Stomoxys* also appear to be important vectors of the disease. Other insects such as *Haematopota spp,* certain species of Chrisoms, *Haematopinus tuberculatus* or even *Aedes aegypti, Aedes argenteus* and *Anopheles filiginosus* have demonstrated their role as vectors experimentally. *Lyperosia minuta* is suspected of having a vector role based on field observations **(Desquesnes, 2013) (A).**

Hippoboscidae (*H. camelina, H. variegata),* Culicidae, Ceratopogonidae, ticks, redevise or even non-biting flies (Muscacrassirostri, at the level of a wound) could also allow the transmission of the parasite It has been demonstrated that trypanosomes can survive for a few hours within ticks of the *Hyalomma genus* in particular, the prevalence of which is high in regions populated by camels **(Sobhy et *al,* 2017).**

Leeches could also transmit the disease, rather in Asian cattle, bats and any material soiled by a contaminated animal could act as a vector of *T. evansi trypanosomosis* **(Desquesnes, 2013).**

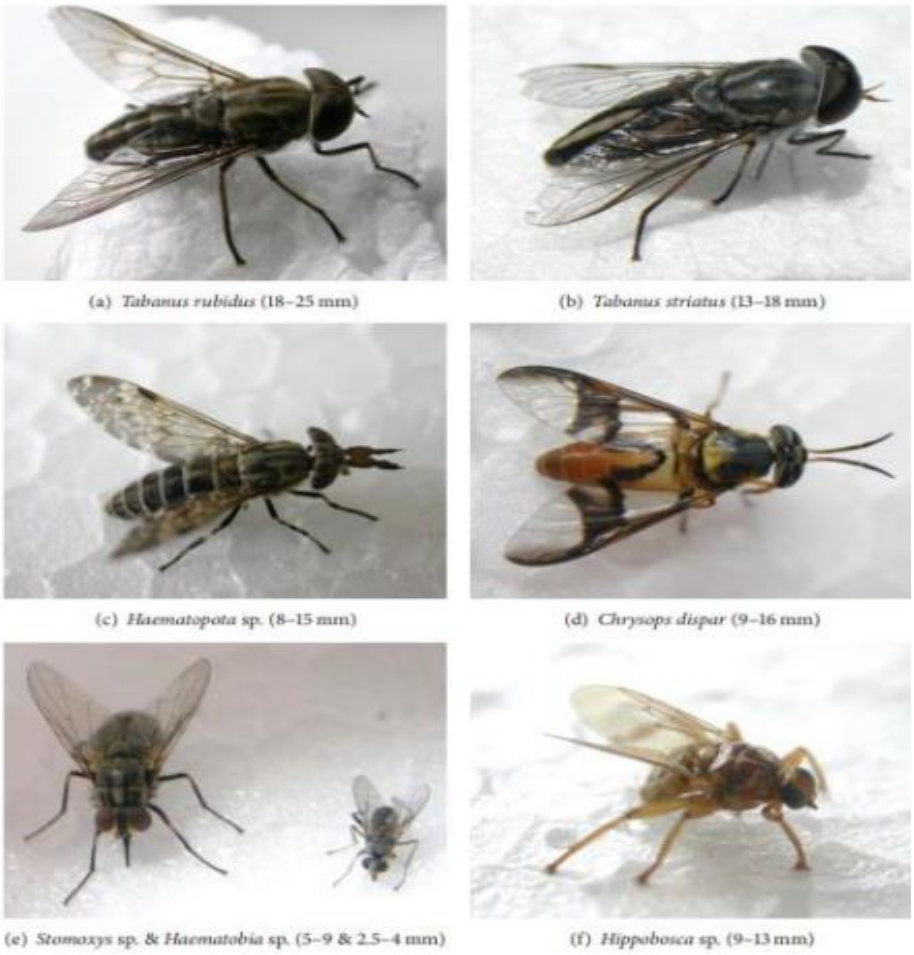


Photo 17: Some of the potential vectors of *Trypanosoma evansi* in Thailand ***(Desquesnes, et al, 2005).***

Transmission in camels is mainly by blood-sucking biting insects, mostly from the Tabanidae family. The fly becomes infected by taking its blood meal from an infected animal. The pain caused by the bite can cause a defensive reaction on the part of the dromedary, interrupting the blood meal of the vector, which will reject the parasite contained in its mouthparts into another animal at the start of the next blood meal, during injection of anticoagulant saliva. The parasite quickly reaches the bloodstream, where it multiplies, from the blood lake created by the bite. In advanced stages, it leaves the bloodstream to reach various extravascular tissues such as the lymph nodes, the brain, the cerebrospinal fluid (CSF), the genitals, the eyes, and the synovial fluid of a joint or even the placenta. The incubation period is 1 to 2 weeks **(Vergne, 2009).**

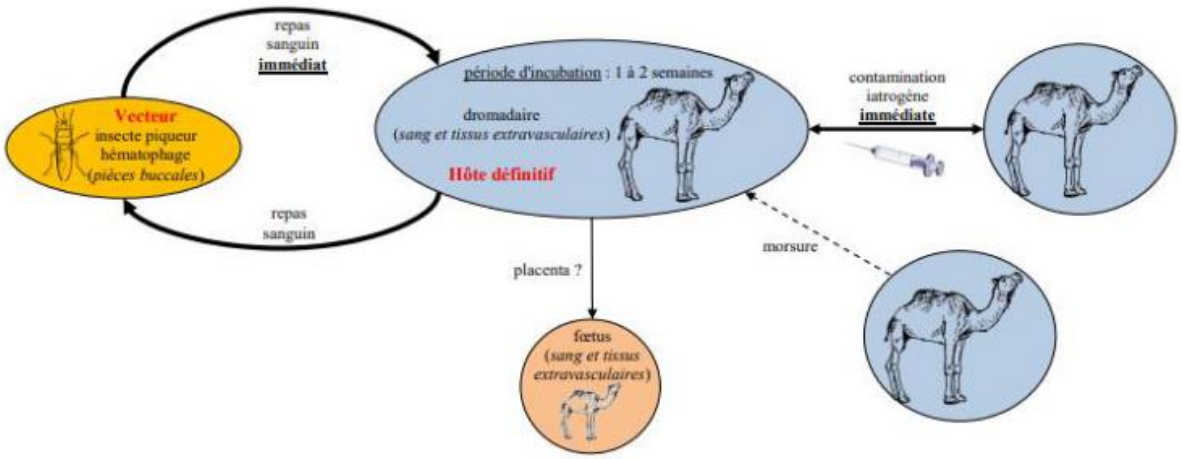


Figure 04: Cycle of *T. evansi* in camels ***(Merlin, 2018).***

Experimental part

Chapter III: Materials and methods

III.1 Study objective

In order to identify blood parasites and external parasites of camel in the southern region of Algeria, a survey was carried out in the region of Laghouat from December 2022 to June 2023.The study included 8 herders from 5 different regions with a total of 115 camels.

III.2 Presentation of the study area

III.2.1Geographical and climatic situation of Laghouat

Covering an area of 27561.6 km², the region of Laghouat, made up of twenty-four municipalities, is installed on two range areas: steppe and pre-Saharian.

It is limited to the north, by the region of Tiaret, to the east, by the region of Djelfa, to the south, by the region of Ghardaïa, to the west, by the region of El Bayadh

Figure05: Geographical location of the region of Laghouat Google (website 02 Algerie-Monde.com).

Climate overview Laghouat spreads out in a Saharan climate. The total annual rainfall recorded is 136 mm distributed heterogeneously. The absolute maximum monthly rainfall observed during the period (1990-2010) is 52 mm recorded during the month of December 1999. The driest month is represented by the month of July (3.5 mm); on the other hand, the rainiest month, relatively, is the month of September with 20.4 mm. It should be noted that the autumn season is relatively the rainiest with 31% of the annual total. The average maximum temperature reaches 38.1°C in August. On the other hand, in January the minimum average temperature reaches 02°C. It should be noted that the absolute maximum temperature is 44.6°C recorded during the month of July 2005; and that the absolute minimum temperature is - 6°C recorded during the month of December 2007. Drought, according to Gaussian's ombrothermic diagram (figure06), is spread

over the whole year in Laghouat. It is accentuated between the end of April and mid-September with low to average relative humidity throughout the year.

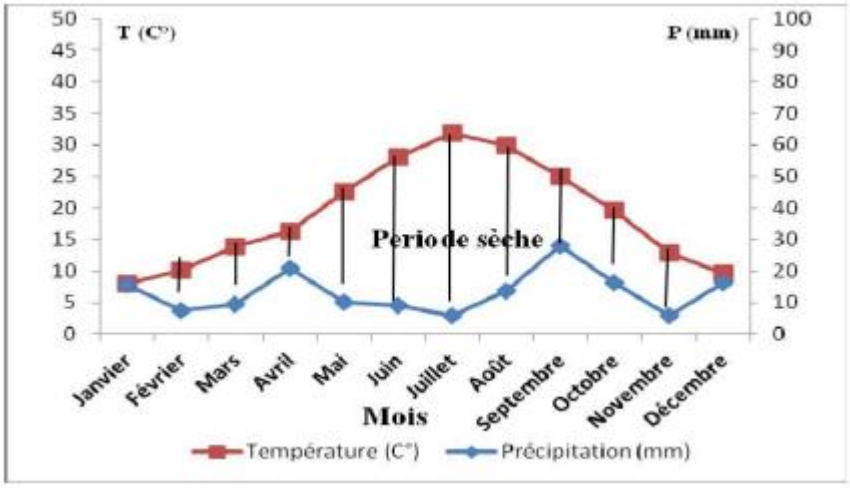


Figure 06: Gausses Ombrothermal diagram for the Laghouat region (1990-2010)

III.3 Choice of stations

To contribute to the assessment of the degree of ectoparasites and haemoparasites in camels sampling is done at 05 regions Laghouat and Ain Madhi and Tadjrona and El Khenag andHassi R'Mel.

III.3.1. Laghouat

Laghouat is a city where the meeting of the Saharan Atlas Mountains, the desert, the rocky ridges and the palm grove form a landscape of sublime beauty. It proudly bears the nickname of the "gateway to the desert. (Website03) (https://www.wikiwand.com/).

III.3.2. Hassi R'mel

Door of the desert, daïra of Laghouat region, is located at a distance of 120 km from the latter and 550 km from the capital Algiers. It is at an altitude of about 750 m. The landscape is a vast rocky plateau. The climate is characterized by low rainfall (200 mm per year) and an average humidity of 20% in summer and 34% in winter, temperatures vary between 10 and +50°C. The region is dominated by high winds, often accompanied by sandstorms **(Kouf D and Laker, 2011).**

III.3.3. Kheneg

It is a commune very close to Laghouat with a distance of 7 km. It is administratively affiliated with the daira of Ain Madhi. It is limited to the north of the commune of Tadjmout, to the east of

Laghouat to the south of the commune of Ain Madhi and to the west of El-Houaita **(Lakhrif and Sia, 2018).**

III.3.4.Ain madhi

Municipality of Ain Madhi in the district of Ain Madhi of the Algerian region of Laghouat,Ain Madhi is located 05 km from the foot of the Amur Mountains on an oval plate s capital more than 60 km from the northeast of Tajmout, the north of Ghisha, the municipality of Wade Mizzi, with the western border of Ghisha, Tajarun, southwestern Al-Bayda and eastern Al-Hawayta and Hassi R'mel. It is world famous as the capital of the Tijanis and has the seat of the corner bearing their name. Nearby is the Kordan Palace, a symbol of tourism in Laghouat (website 04 https://fr.wikipedia.org/wiki/Wikip%C3%A9dia:Accueil_principal).

III.3.5.Tadjrouna

The municipality of Tadjrouna is located in the southwest of the region of Lghouat and was administratively subordinate to the municipality of Aflou until 1976. A modern village was built north of the old palace, which includes modern housing and several facilities. Meron is a municipality since 1984, bordered from the north by the municipality of Taweyala, from the east by the municipality of Ghisha, from the south by the municipality of Ain Madhi and from the west by the municipality of Prizin, which belongs to the region of El baeid. The city is located about 20 km from the foot of Mount Amor, about 82 km from the state capital. (Website 05) **(**https://en.wikipedia.org/wiki/Main_Page **).**

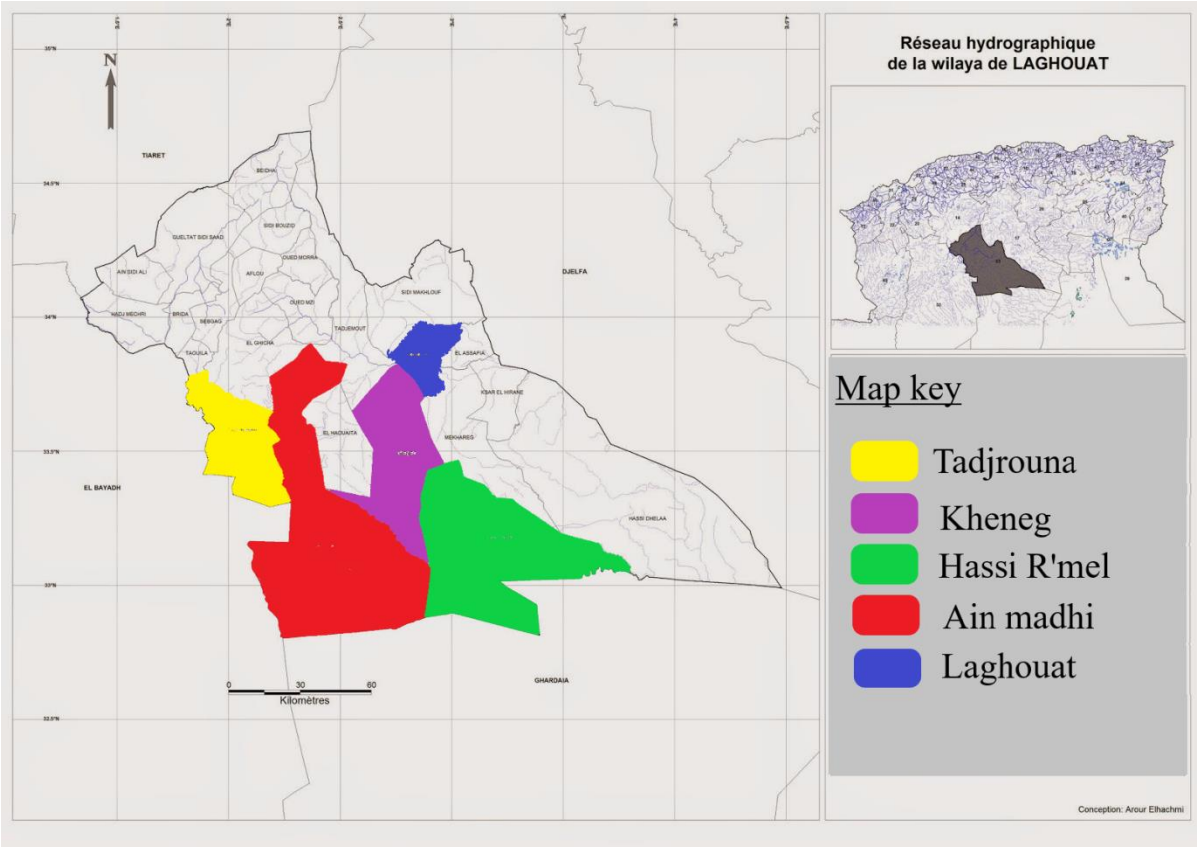


Figure07: Map of municipalities in Laghouat ***web site06.***

III.4. Characteristics of farms visited

To carry out our study, we took 115 samples from 8 farms in different places in Laghouat. Each farm has different characteristics. Photo 18 represents the example of breeding in the commune of Ain madhi.

Photo 18: Camels visited in the town of AinMadhi*(Original photo, 2023).*

The following table represents the characteristics of the farms visited.

Table 02: Characteristics of farms visited (2023)

Criteria	Variables	Number of farms	%
Localities	Laghouat	1	12.5%
	Ain Madhi	2	25%
	Tadjrouna	2	25%
	Kheneg	2	25%
	Hassi R'mel	1	12.5%
Breeding method	Transhumant	1	12.5%
	Nomadic	1	12.5%
	Sedentary	6	75%
kind of food	barley flour	1	12.5%
	Plants	1	12.5%
	Mixed	6	75%
Aim breeding	Milk	3	37.5%
	Meat	1	12.5%
	meat and milk	1	12.5%
	Other	3	37.5%
Vaccination	presence	2	25%
	Absence	6	75%

III.5. Characteristics of the animals visited

The following table represents the characteristics of the animals visited

Table03: The characteristics of the animals visited (2023).

	Variables	Laghouat	Ain Madhi	Tadjrouna	Kheneg	Hassi R'mel	Number total	%
Sex	Female	5	19	39	9	10	82	71.3%
	Male	1	3	15	5	9	33	28.69%
Age	Young	5	3	0	2	6	16	13.91%
	Adult	1	19	54	12	13	99	86.08%
Judgement	Healthy	6	6	48	10	19	94	81.73%
Clinical	Sick	0	16	6	4	0	21	18.26%
Specimens	Ectoparasites	0	20	0	12	0	32	27.82%
	Haemoparasites	6	22	54	14	19	115	100%

III.6 Development of study

To carry out our studies and through the questions posed to the breeders, we were able to determine the age and state of health of the camels in each herd and the purpose of their. Have breeder's undergone pretreatment and determined the quality of the feed provided and the type of breeding? Are there any doubts about the likelihood of infecting any of the camels?

III.7 Sampling

The quality of the final report written will be influenced by the quality of the sample taken and submitted for analysis. The taking of a sample of the parasite is a delicate operation to which the greatest care must be taken; it conditions the analytical results and the interpretation which will be given **(Rodier, 2009).** The objective is to obtain a sample as representative as possible of the

parasite to be examined without contamination or modification. Precautions must be presented at several levels: sampling equipment, sampling method, transport, storage and labeling of samples **(Rejsek, 2002).**

III.8 Biological material

Our biological material is represented by camels (Photo19). We chose to work on this species because it provides many services to humans, who use it for their hair, milk and meat. Besides being used for transportation, it allows humans to live in desert environments. So the search for parasites seems very interesting to preserve this species.

Photo19: Camels visited in the municipality of Tadjrouna*(original photo 2023)*

III.9. The methods

III.9.1.1 Collection of ectoparasites

To collect ectoparasites, all body parts of sampled camels are visually inspected, ectoparasites (ticks) were counted, and we made an estimate of the number. Isolate ticks from each individual host in a vial identified with a label (Photo19). It is important to indicate the hosts that searched even if no parasites were collected.

Photo20: Collection of ectoparasites*(Original photo 2023).*

III.9.1.2 Conservation of ectoparasites

The ectoparasites collected are preserved in hermetically sealed bottles by adding alcohol at 70° or in a preservation solution (80% ethanol 90% and 15% distilled water and 5% glycerol and 1% chloroform), until at the identification stage which will be done in the laboratory of pasitology of Ammar Thelidji with a binocular magnifying glass, microscope and identification keys were used to identify the arthropod species.

Photo21: Tick preservative (Original photo 2023).

III.9.1.3Identification of ectoparasites

Determination of ectoparasites ticks, fleas and lice are identified in the laboratory using a magnifying glass and a microscope based on guides (Ticks of domestic Animals in Africa to Identification of Societies Revised2014 and Ticks of Europe and North Africa a Guide to species identification (2017).

III.8.1.4 Identification by keys

Thus the systematic characters represented in the figures (fig20.21.22) and the observation of the following morphological characters:

- the position of the anal furrow
- The presence or absence of a posterior festoon
- the comparison between the 2nd and the 3rd article of the palp
- The shape and size of the rostrum and the shape of the base of the capitalism.

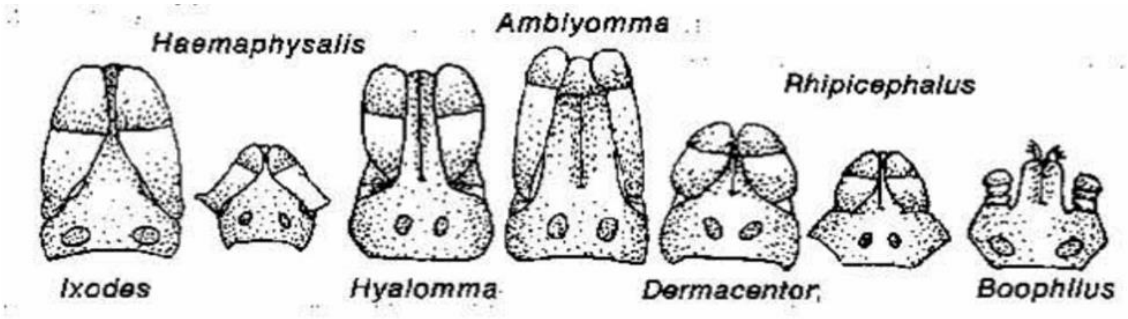


Figure 08: Different types of capitalism among the Ixodina (Website 07).

III.2.Hemoparasites

III.9.1Blood sample

The blood sample should be taken as sterile as possible by venipuncture. In large mammals, the jugular vein or a tail vein will be used. Veins from the mammary gland or limbs can also be used. The vena cava can also be used in camellias. The auricular vein or the retro-orbital vein can be chosen to obtain a blood sample. The blood sample is taken by means of a syringe and a needle or by means of a needle connected to a vacuum pump by means of tubing (this method is not easy for the veins fine, but works well for large veins) **(OIE Terrestrial Manual, 2005)**.

Photo 22: We take the blood sample (original photo 2023)

III.9.2. Conservation of blood samples

For the collected blood samples are 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 the Take it quickly to an analytics informant **(OIE Terrestrial Manual, 2005).**

Photo23: Storage of blood samples***(original photo 2023).***

III.9.3The blood smear

-Principle: a drop of blood spreads evenly on a glass chip for a uniform thin layer.

- Procedure

a. Preparinga blood smear

Place a drop of blood on the end of a slide. Apply another angled blade to45° in front of the drop of blood so that the blood spreads out under the blade by capillarity. Slide the angled blade to evenly spread the drop of blood.

b. Coloring with May-Grunwald Giemsa

May Grunwald-Giemsa's colored blood swab or Giemsa's simple coloring is done as follows:

* Step 1: Let the blood swab dry.

* Second step; Tarnish. It has 2 steps:

• Attach the smear to May Grünwald (MG): leave it for 5 minutes. Rinse with tap water and leave to dry.

• Smudging Jimsa: Immerse the blade in a water solution from Jimsa (1 ml versus 9 ml distilled water) for 20 minutes. Rinse with water then dry and scan the smear with microscope at target * 100(***Dr. BENTAHAR AssiaUniversity*of Ferhat Abbas Sétif 1**)

III.10 Statistical analysis

Parasitological indices

After the examination of 115 animals listed on five zones by specific techniques, the method of analysis adopted in this study is essentially a descriptive statistical analysis. We used the SPSS software for the calculation of the prevalence of the infestation the realization of the curves, as well as a Chi 2 test was used to determine the relationship between the prevalence of the infestation and certain parameters such as (age, sex…).

We calculated the prevalence of infestation according to Albert and Bush.

- **The specific prevalence (P %):** is the ratio of the number of infested hosts (parasitized camels) by a given species of parasites to the number of camels examined.

P= NCI/NCE×100

P: prevalence.

NCI: Number of infested camels.

NCE: Number of camels examined.

A species is said to be: Dominant, if P >50%; Satellite, if $15 \leq P \leq 50\%$; Rare, if P < 15%.

Chapter IV

Results and discussion

IV. Results

In this chapter we will present the results obtained by parasitological analyzes of blood, blood smears and the identification of ectoparasites. These results will be exploited using statistical and parasitic indices.

IV.1. Total prevalence of the infection by parasites

In our study we found 33.9% of camels infected with parasites and 66.1% uninfected in the total studied camels 115.

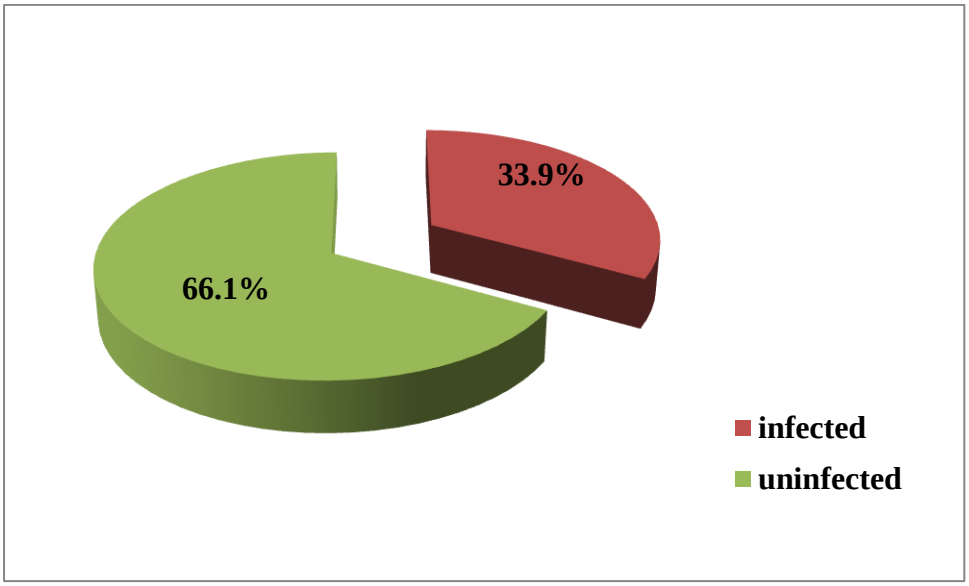


Figure09: The figure shows the proportion of infected and uninfected camels.

IV.2.Results of the ectoparasites

This part gathers the results of the ectoparasites of camels found in the study region from December 2022 to June 2023.

IV.2.1 Systematic list of ectoparasites found in the study area

The identification of the different species of ectoparasites collected on camels, are grouped in the following table:

Table 04: Systematics of camels ectoparasites.

Phylums	Classes	Orders	Families	Species	Common name
				Hylomma dromedarii	

Arthropods	Arachnid	Ixodida	Hylomma	*Hyalomma impeltatum*	tick

We have inventoried 2 species of ectoparasites, belonging to 1 phylum (Arthropoda), classes (Arachnida), orders (Ixodida) and family (Hylomma). The order of Ixodida is best represented with 2 species (Hylomma dromedarii and Hyalomma impeltatum).

A: ventral face of Hyalomma dromedarii B: Dorsal face of Hyalomma dromedarii

Photo24: *Hylomma dromedarii spp* Male *(original photo2023).*

A: ventral face of Hyalomma dromedarii B: Dorsal face of Hyalomma dromedarii

Photo25: *Hylomma dromedarii spp* Female *(original photo2023).*

A: ventral face of Hyalomma impeltatum **B:** Dorsal face of Hyalomma impeltatum

Photo26: *Hyalomma impeltatum spp* Male *(original photo2023).*

Photo27: Dorsal face of *Hyalomma impeltatum spp* Female *(original photo2023).*

IV.2.3Prevalence of the infection by ectoparasites

As we see 28% of camels infected by the ectoparasites, and 72% uninfected by ectoparasites in totals of 115 camels we have.

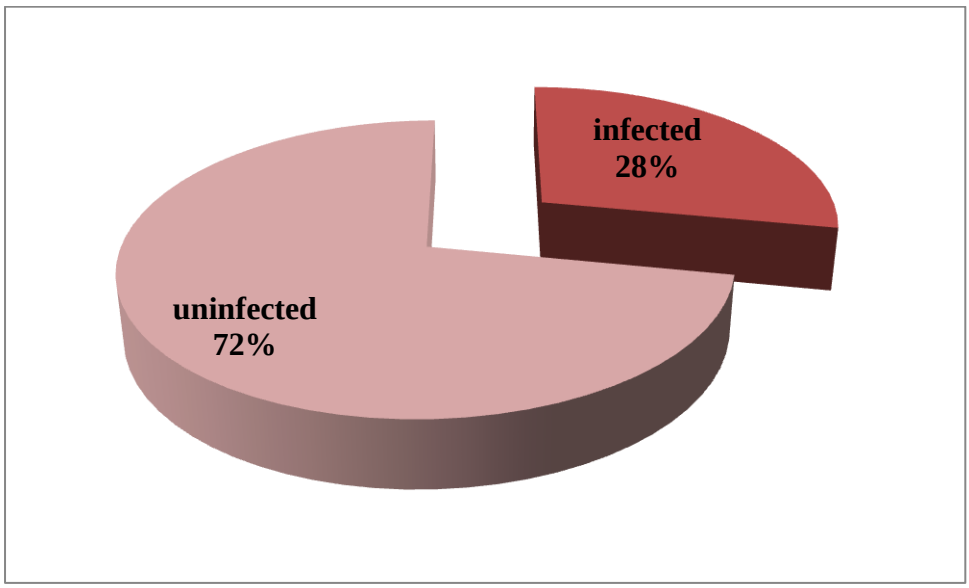


Figure10: The figure shows the proportion of infected and uninfected camels by the ectoparasites.

IV.2.4 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 135male and 27 female. Both species are represented by 187adults with a total number of males and females.

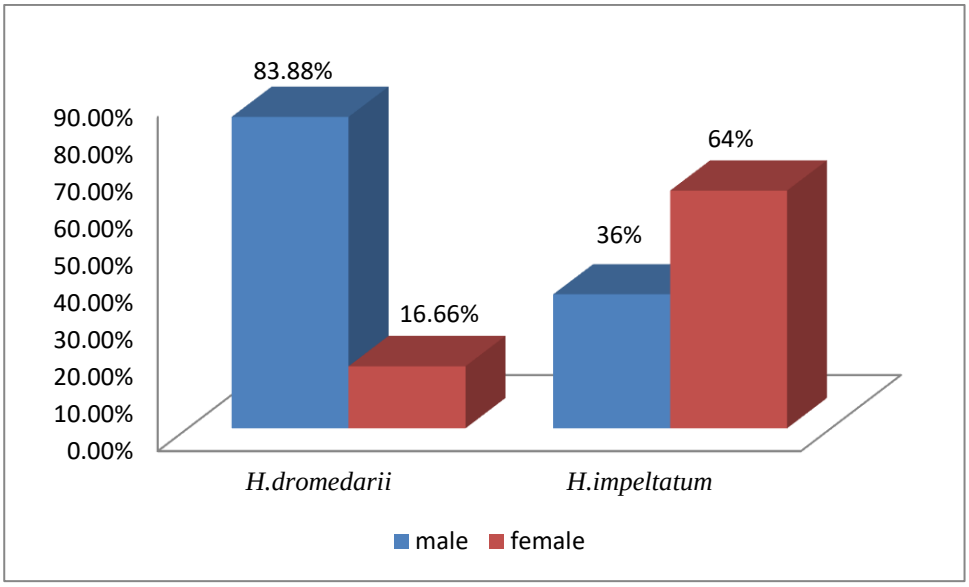


Figure 11: numbers of ticks according to their species.

IV.2.5 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 individuals (8.75 %) (Table05).

Table 05: Association of ectparasite genera in the examined camels.

Association of parasites	N	%
Hyalomma Dromedarii	22	19.25 %
Hyalomma Dromedarii* + *Hyalomma Impeltatum	10	8.75 %

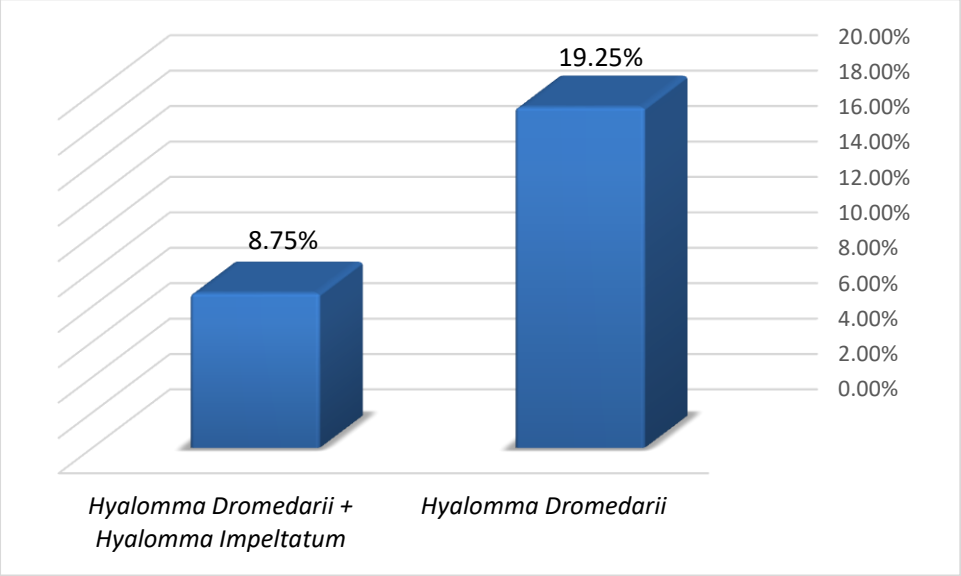


Figure 12: Percentage of ectoparasite coexistence.

A-Prevalence of ectoparasite by age

In the following figure we find that 27.3 % of adults have the infection by the ectoparasites, while that 31, 3 % of young's infected also. The statically analysis showed that is no signification (p=0.74).

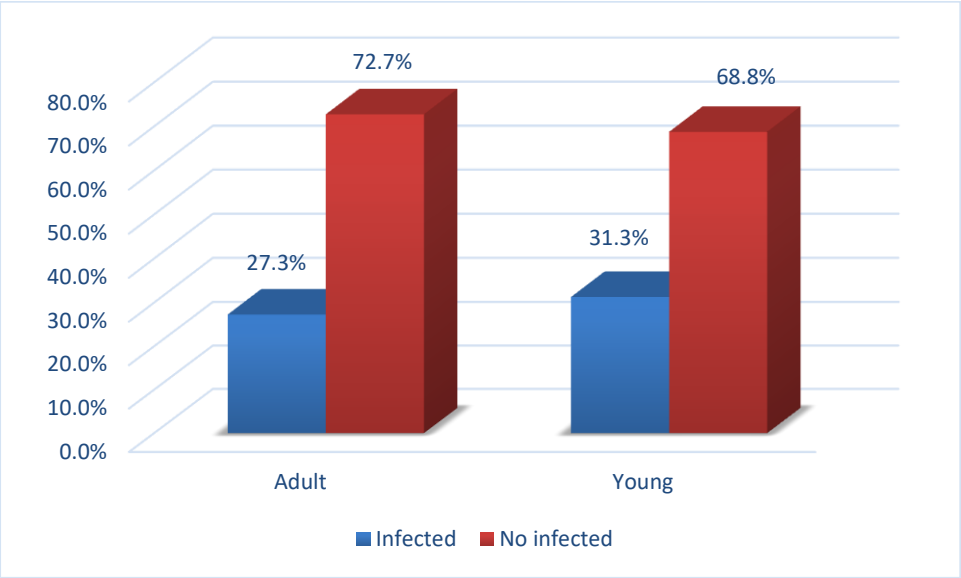


Figure 13: Prevalence of ectoparasites by age of camels.

B-Prevalence of ectoparasite by sex

From the figure we have 21.9% males infected, less than the 30.1% female infected by the ectoparasits, the statistic show that is no signification (p=0.37)this is due to the fact that our study was based mainly on females more than males .

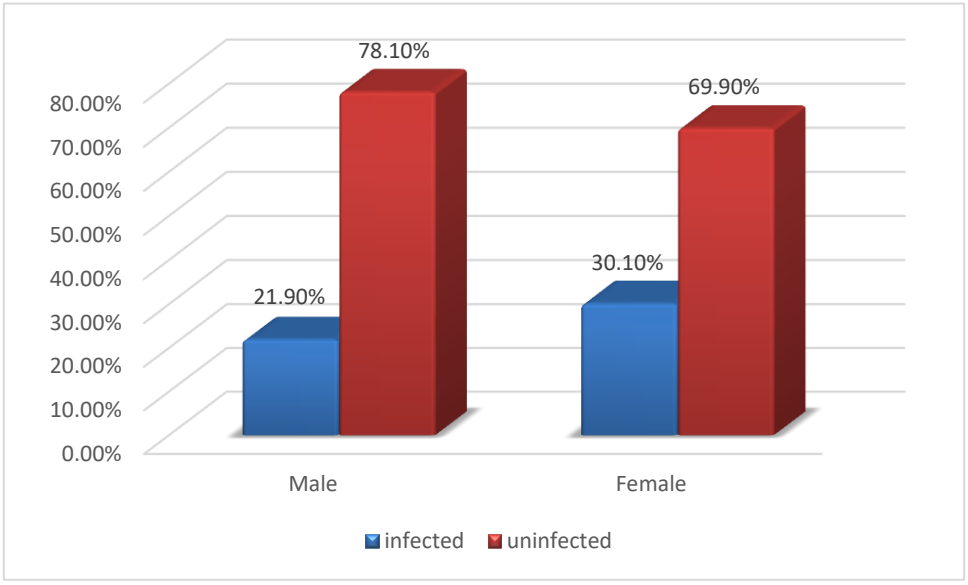


Figure 14: Prevalence of ectoparasite by sex of camels.

C-Prevalence of ectoparasite by type of food

We have 88.9% infected who eat natural plants barley wheat and all, there is a signification (p=0.00) we can say that it is a relationship between ectoparasites and type of food.

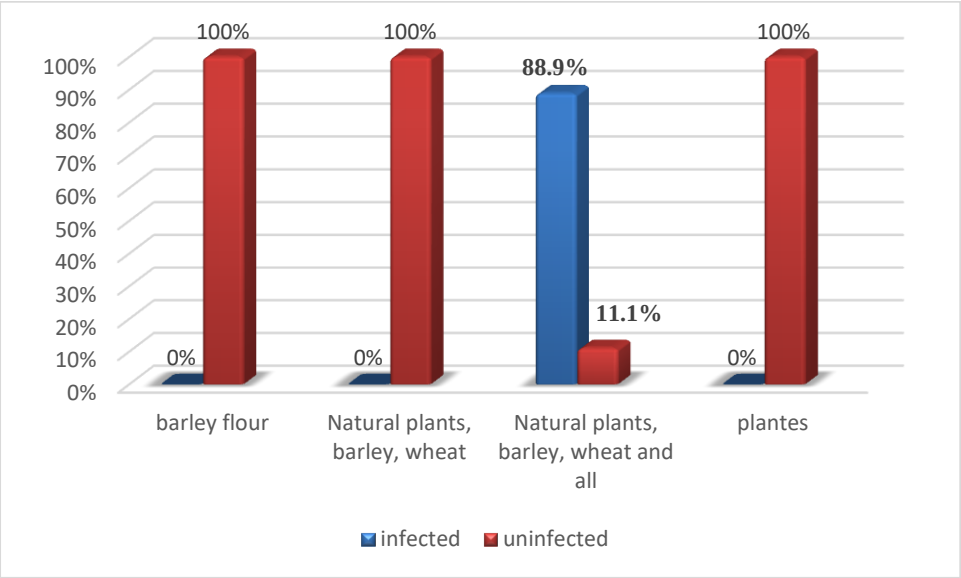


Figure 15: Prevalence of ectoparasite by type of food of camels.

D-Prevalence of ectoparasite by mixed breeding

We have 74.4% camels live with other animals and Share the same space (mixed breeding) infected, Coues they don't chair the same space. The statistical show there is a signification (p=0.00).

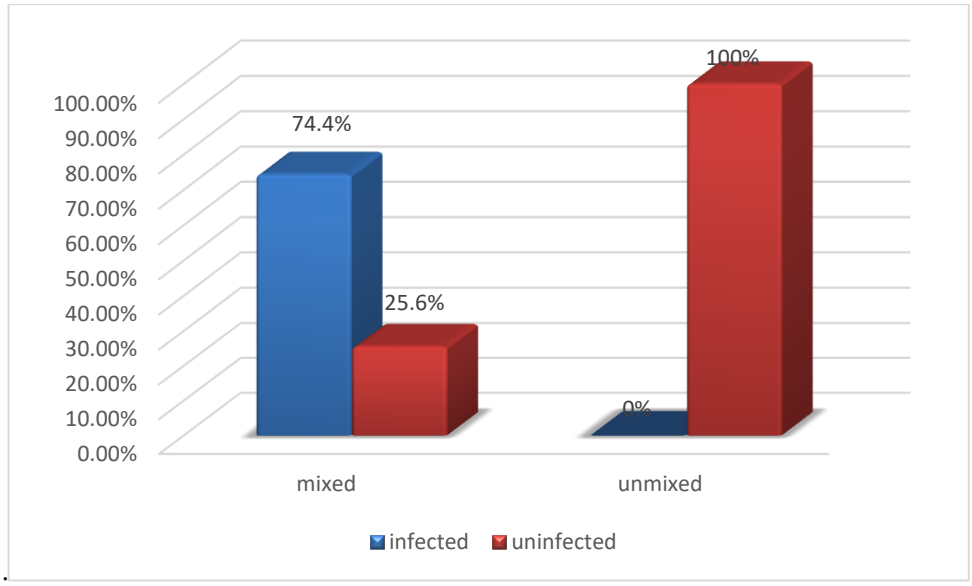


Figure 16: Prevalence of ectoparasite by mixed breeding.

E-prevalence of ectoparasite by type of breeding

The chart show that in sedentary we have 76.2% of camels infected, we realized that type of breeding has no effect on the infection by ectoparasites, the statistic show that is a significant (p=0.00).

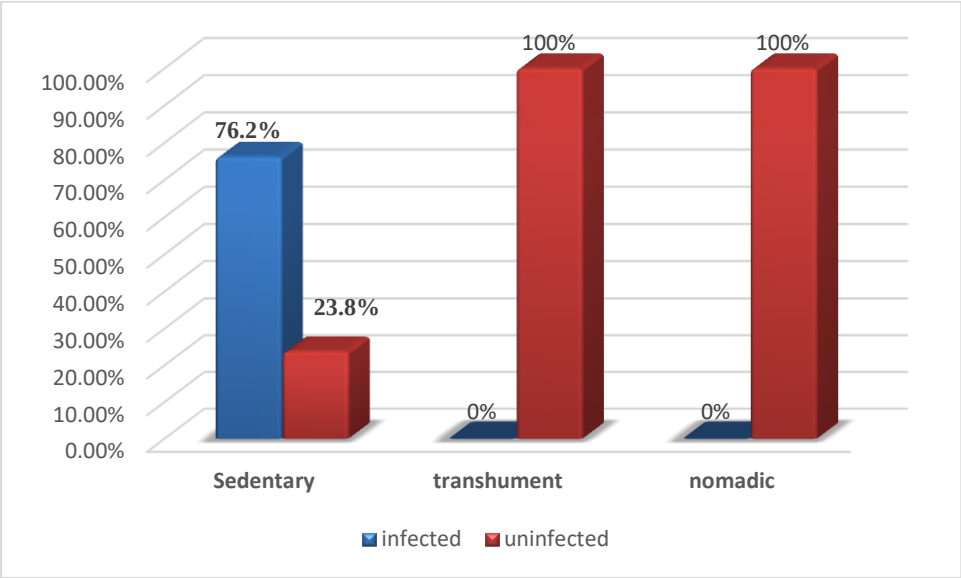


Figure 17: prevalence of ectoparasites by type of breeding.

F-Prevalence of ectoparasite by clinical jujement

As we see from the chart 71.4% sick camels infected, and 18.1%healthy camels infected we realized that there is relationship between the infection by ectoparasit and clinical jujement (p=0.00).

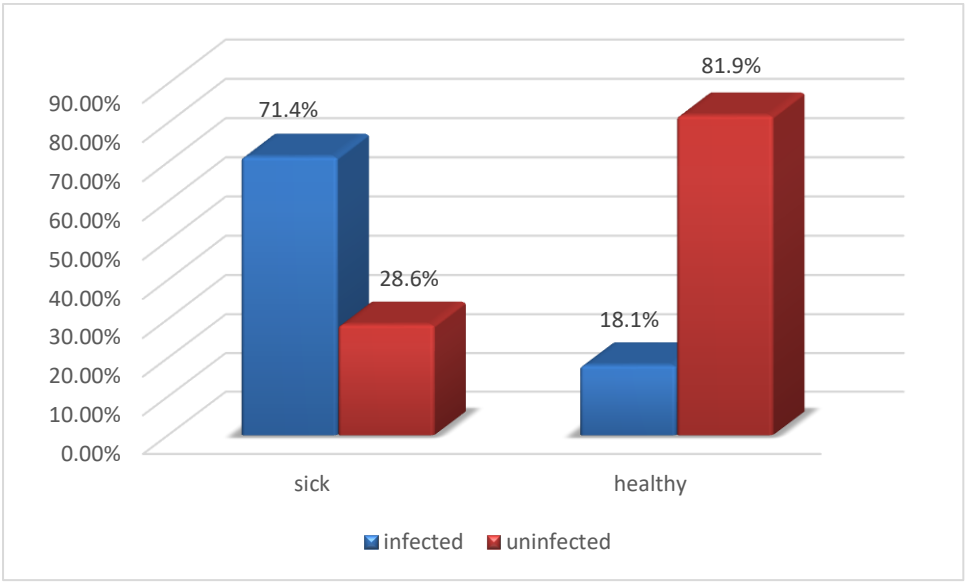


Figure 18: prevalence of ectoparasites by clinical jujement.

G-Prevalence of ectoparasite by breeding objectives

From the chart we see 35.6% camels infected with ectoparasites breeding for their milk and all (p=0.02) show that is significant, because there is relation between breeding objectives and ectoparasites.

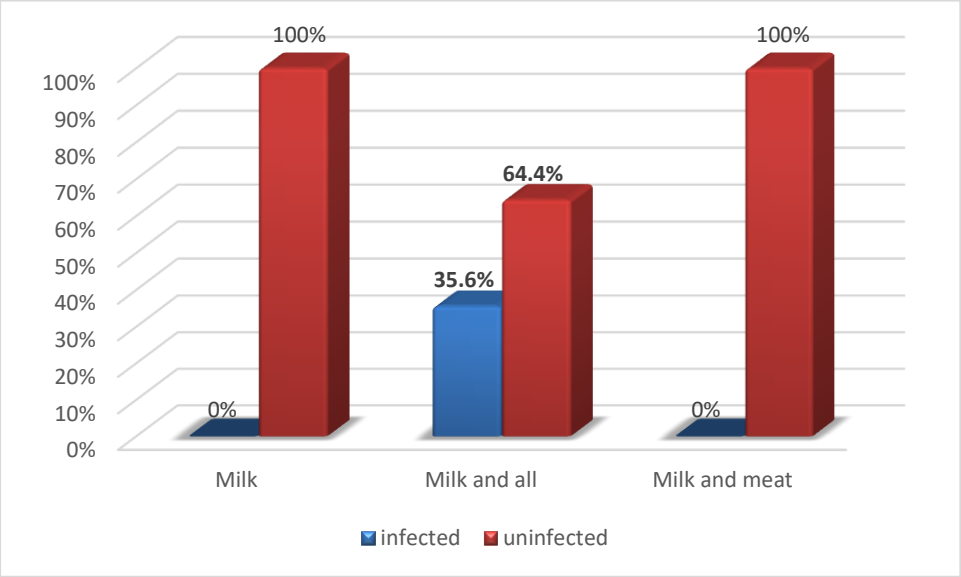


Figure 19: prevalence of ectoparasites by breeding objectives.

H- Prevalence of ectoparasite by study area

The figure19 show that in Ain madhi 90.9% camels infected ,and in Kheneg 85.7%camels infected, the statistic show that is significant (p=0.00).

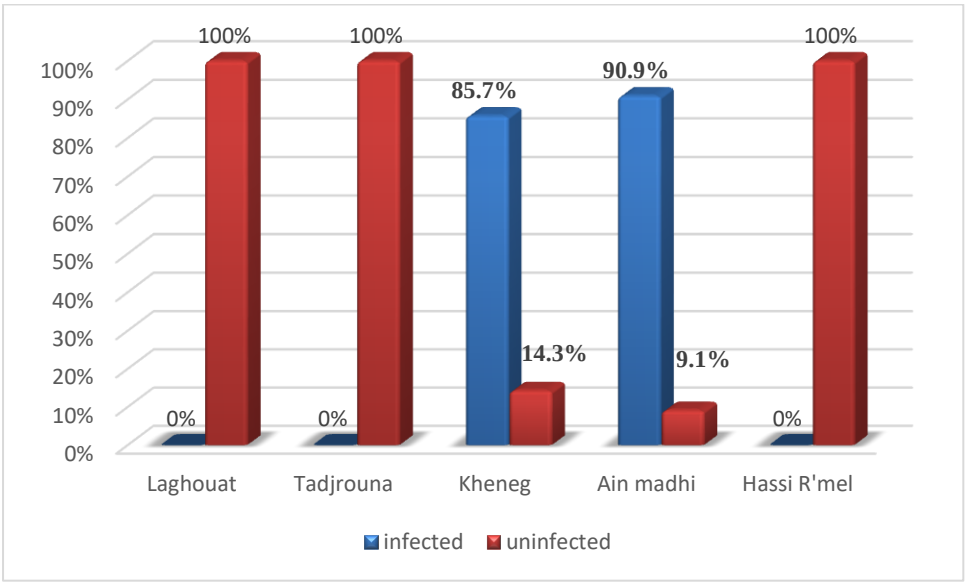


Figure 20: prevalence of ectoparasites by study area.

I-Prevalence of ectoparasite by treatment

We can see that 35.6% camels untreated have the infection by ectoparasites, (p=0.00) that is significant it means it is effect on the infection.

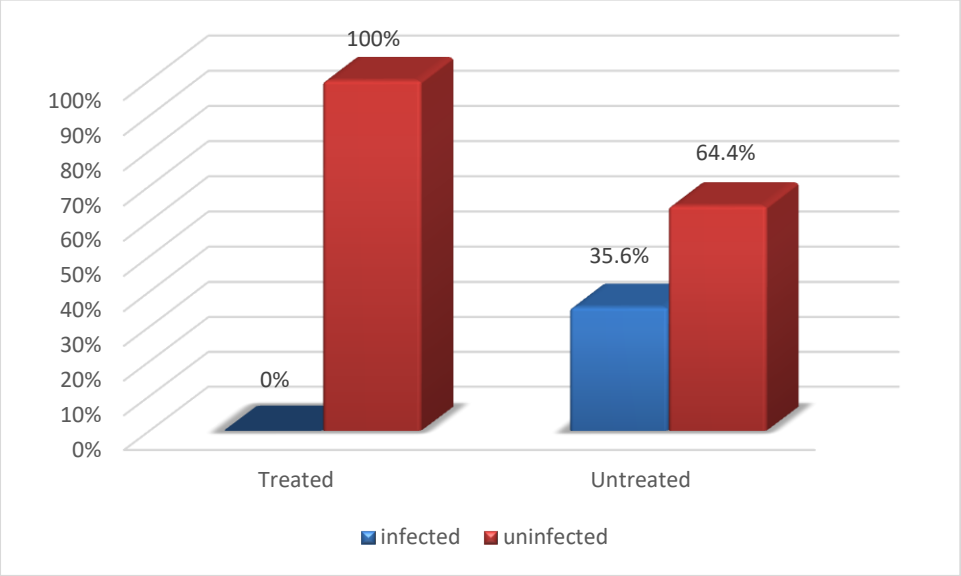
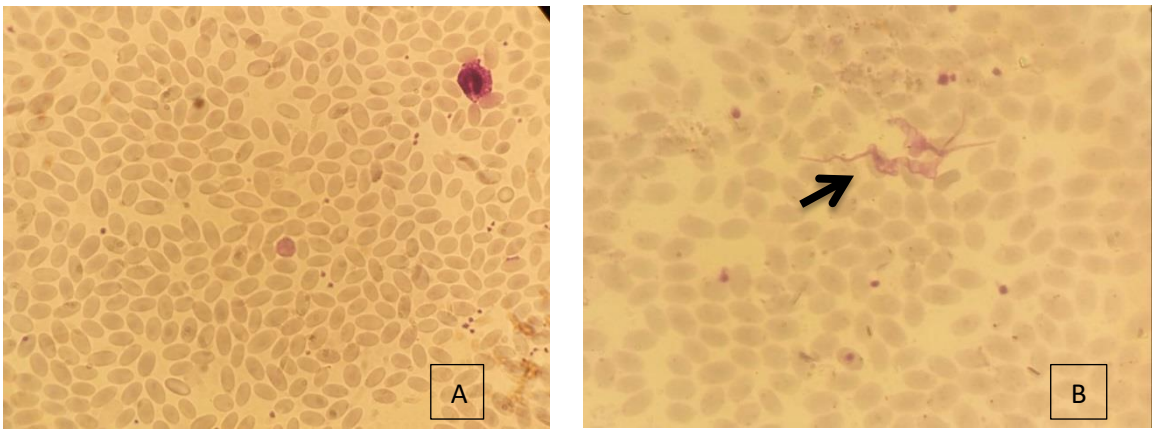


Figure 21: prevalence of ectoparasites by treatment.

IV.3 Blood Test Results

During the study period, blood samples were taken from 115 camels, 83 of which were female and 32 of which were male. We found that 3 parasitic species of blood were present in 28 camels (24.34%). These species are represented by *Trypanosoma spp, Babesia spp* and *Theileria spp, Babesia spp* which is most reported with a prevalence of 28 camels with 24.34 %, followed by *Theileria spp in* 17 camels with 14.78%, than *Trypanosoma spp* with equal numbers of 3 camels 2.60%.



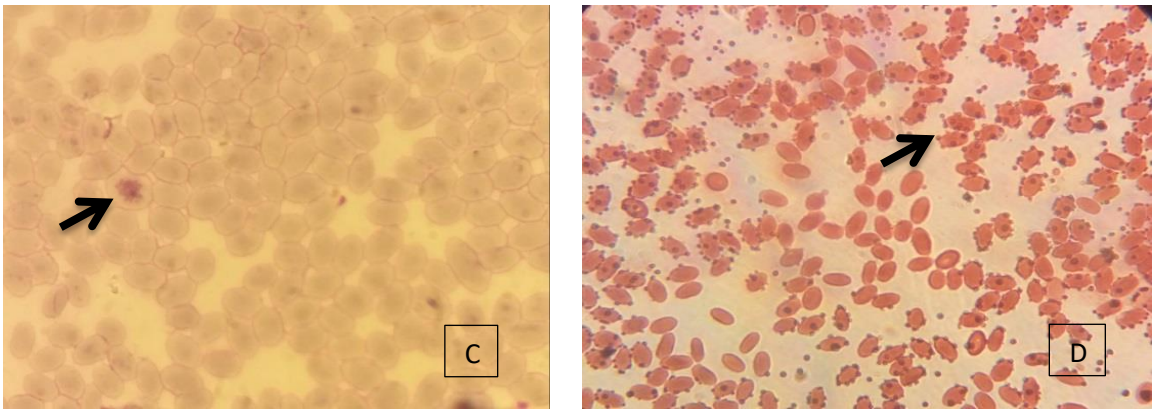


Photo28: Parasite-infected blood smears (original photo 2023)

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

IV.3.1. General Prevalence of haemoparasite

From the 115 camels studied, we can see that 28 were infected with haemoparasite 24.34%.

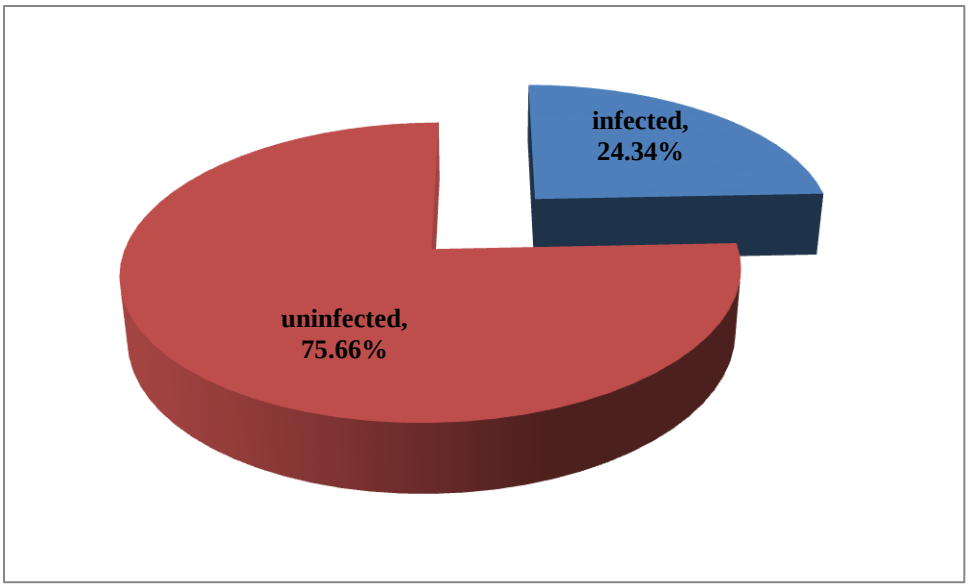


Figure22: The total prevalence of haemoparasite in camels.

IV.3.2 Prevalence of haemoparasite according to their species

We see the most dominant haemoparasite with 28 (24.34%) of camels infected by *Babesia spp*, followed by *Theileria spp* with 17 (14.78 %) infected camels, than *Trypanosoma spp* less dominant with 3 camels (2.6%) infection.

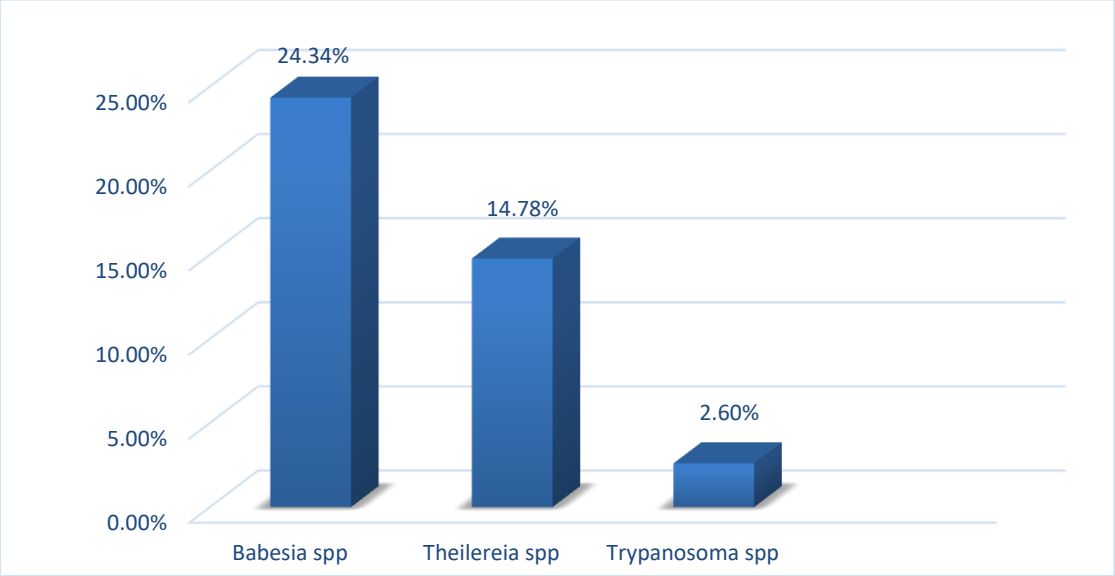


Figure 23: Prevalence of haemoparasite according to their species.

IV.3.3 Association of parasites (Poly parasitism)

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

Table 06: Association of haemoparasite genera in examined camels.

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

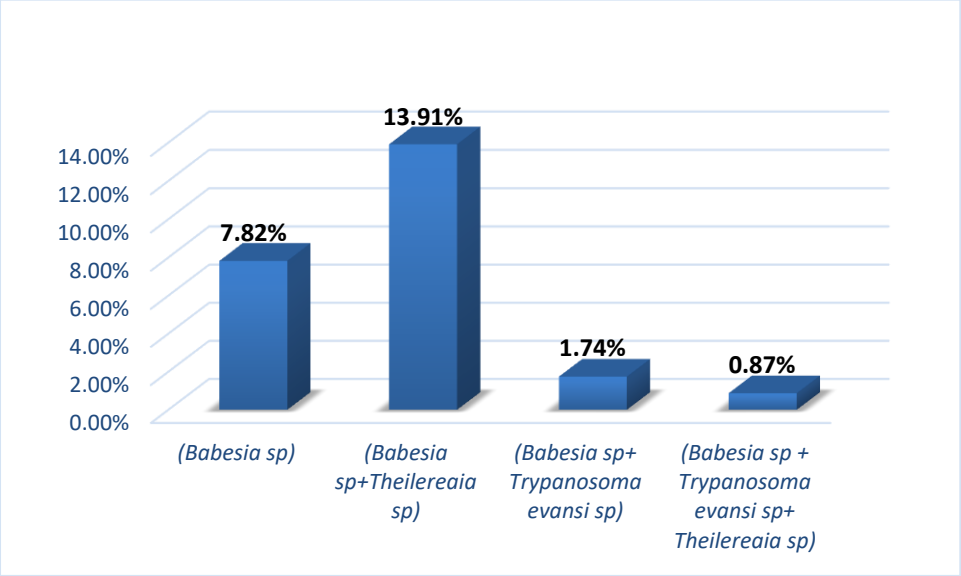


Figure 24: Percentage of haemoparasite coexistence.

IV.3.4 Relationship between haemoparasite and other parameters

After analyzing the results of the work we have done, we will compare the results with some other factors that contribute to the spread of ectoparasites and haemoparasites in dromedaries, such as: age, sex, mode of breeding, clinical status, presence or absence of treatment, and purpose of rearing (production).

A-Prevalence of haemoparasite by age

The relationship between haemoparasite and different age groups shows that the prevalence of the infection in young camels was 25 % more than in adult camels were 23.2%. The statistical analysis showed that the difference was not significant (P = 0.87).

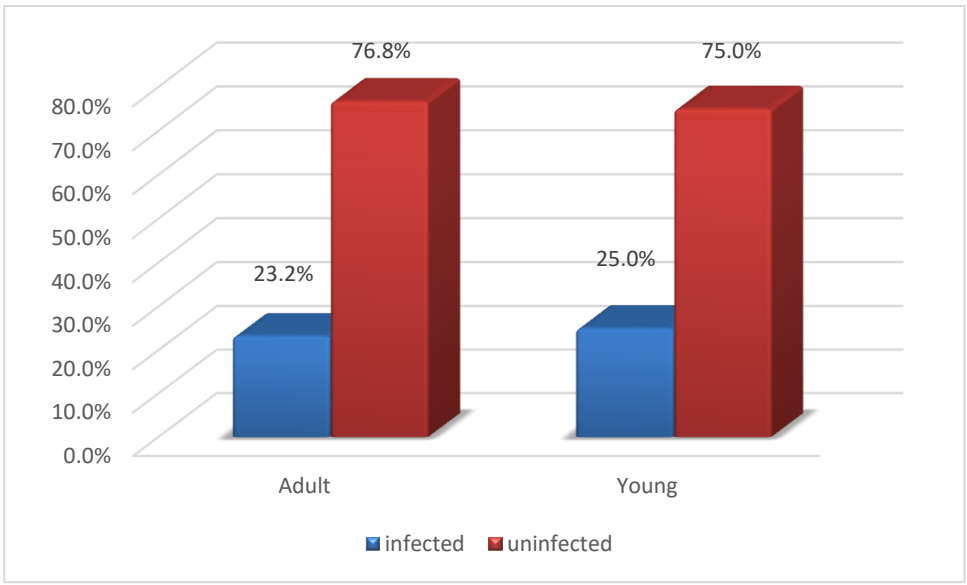


Figure 25: Prevalence of haemoparasite by age of camels.

B-Prevalence of haemoparasite by sex

The figure shows that the prevalence of the infection in females was 21.7 %,while that less than males was 28.1 %.The statistical analysis showed that the difference was not significant (P = 0.46) it means it don't effect on the infection.

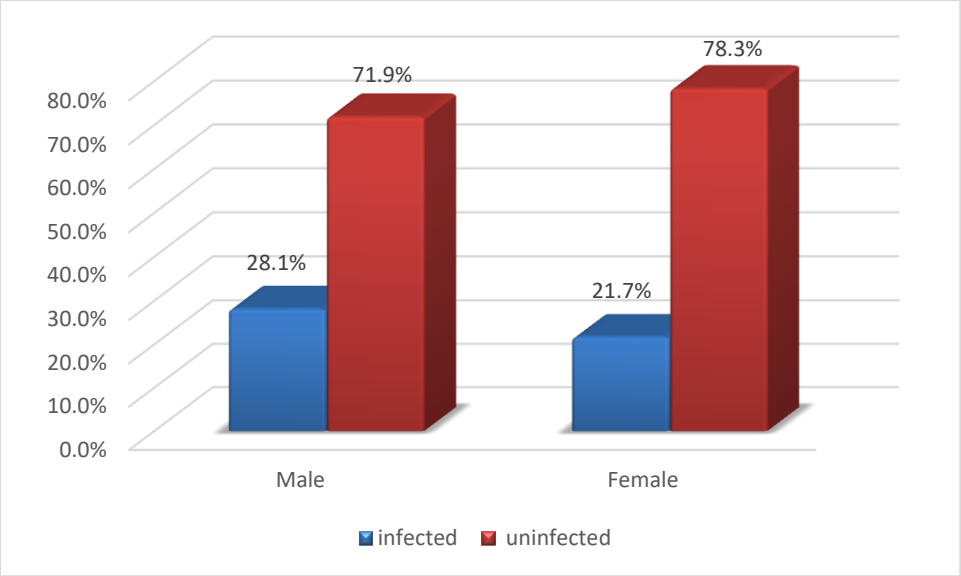


Figure 26: Prevalence of haemoparasite by sex.

C-Prevalence of haemoparasite by type of food

We have natural plants barley wheat 13%of camels infected and the rest 87%uninfected , in other side we have 55.6% infected who eat natural plants barley wheat and all, we realized there is no signification(p=0.00), we can say there is a relationship between type of food and the infection by haemoparasites .

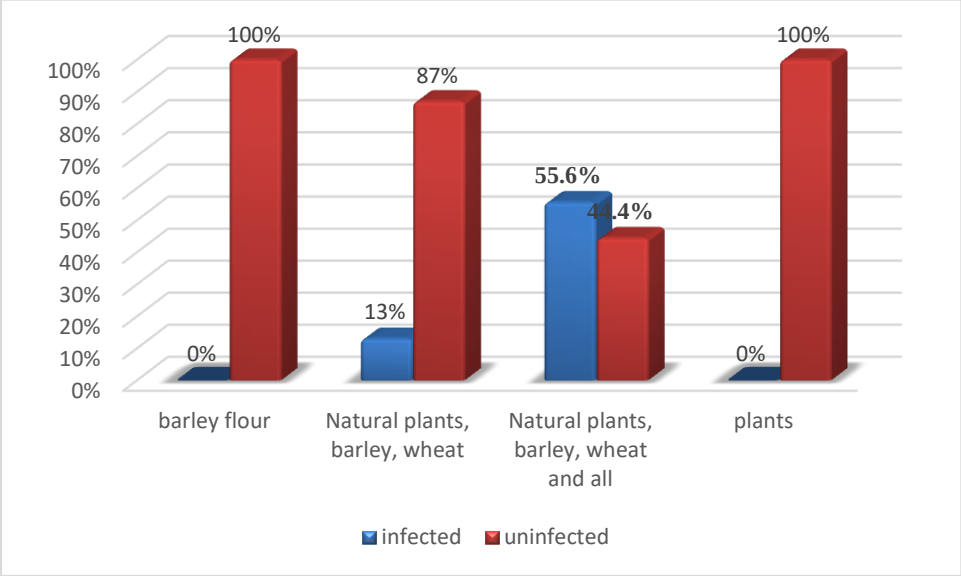


Figure 27: Prevalence of haemoparasite by type of food.

D-Prevalence of haemoparasite by mixed breeding

As we see from the figure we have 46.5% camels live with other animals and Share the same space (mixed breeding) infected in other side 9.7% unmixed have the infection. The statistical show there is a signification (p=0.00), it means that is an effect.

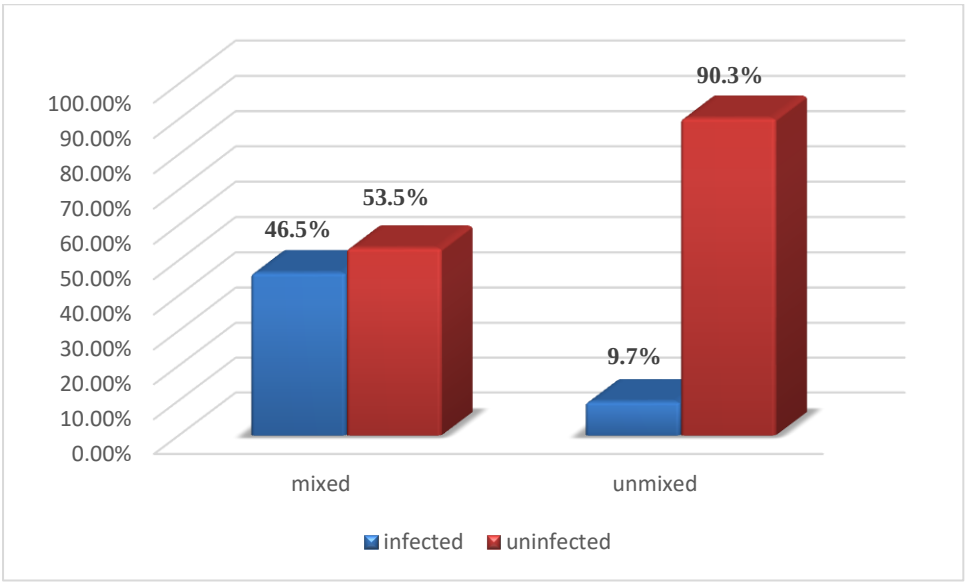


Figure 28: Prevalence of haemoparasite by mixed breeding.

E-prevalence of haemoparasite by type of breeding

In in sedentary breeding 47.6% infected camels, followed by 13% camels infected and in transhumant. The result of the statistic show there is a signification (p=0.00)

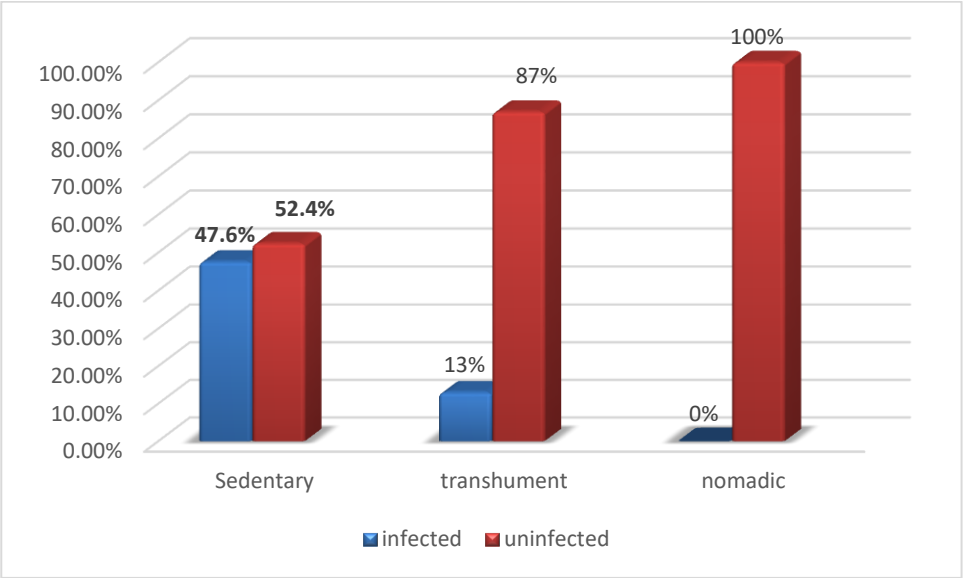


Figure 29: Prevalence of haemoparasite by type of breeding.

F-Prevalence of haemoparasite by clinical jujement

We have only 6.4% healthy camels infected, than we realized there is a signification (p=0.00), we can say the clinical jujement has a relation with the infection by haemoparasites.

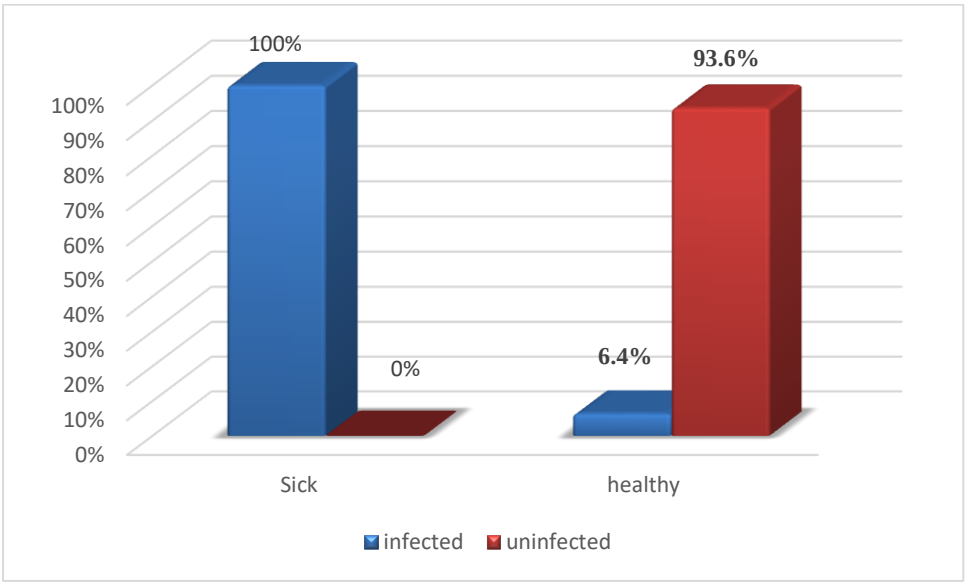


Figure 30: Prevalence of haemoparasite by clinical jujement.

G-Prevalence of haemoparasite by breeding objectives

From the chart we see 30% camels infected with haemoparasites who breeding for their milk and all, we can see from the statistic (p=0.07) that is significant it means there is a relation between breeding objectives and haemoparasites.

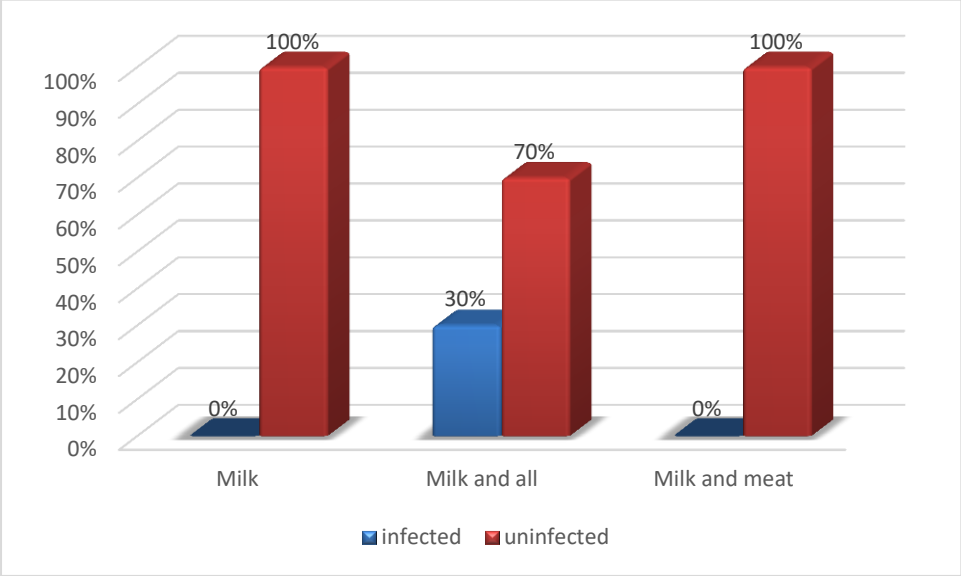


Figure 31: Prevalence of haemoparasite by breeding objectives.

H- Prevalence of haemoparasite by study region

The figure 32 show that in Ain madhi 72.7% camels infected, followed by Kheneg with 28.6%camels infected, than Tadjrouna we have 13%of camels infected, the statistic show that is a significant (p=0.00), the study area has effect on haemoparasites.

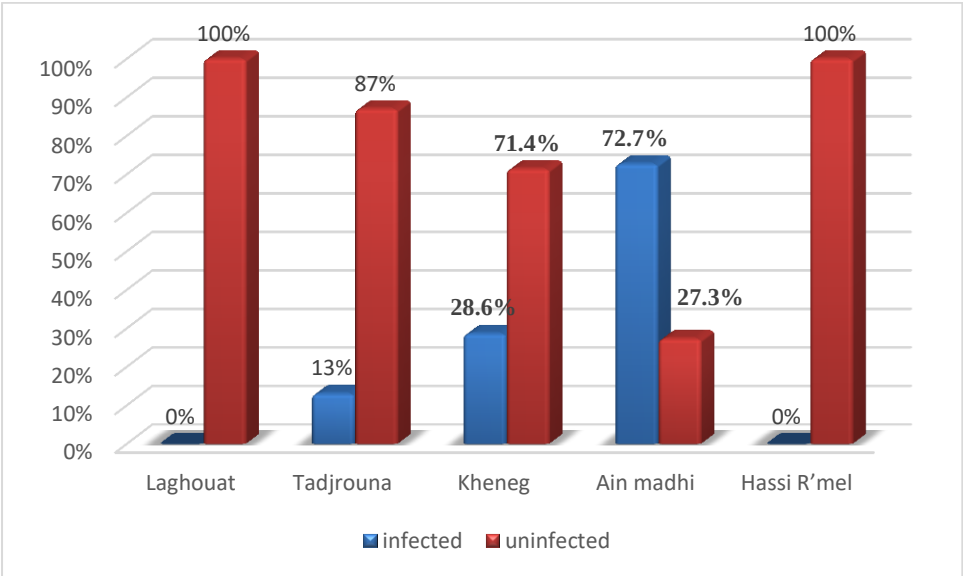


Figure 32: Prevalence of haemoparasite by study area.

I- Prevalence of haemoparasite by treatment

We have 30% camels untreated are infected, we found from the statistical (p=0.002) there is signification, we can see that treatments have in important role on the infection by haemoparasites, there is reel relationship between treatments and the infection by haemoparasites.

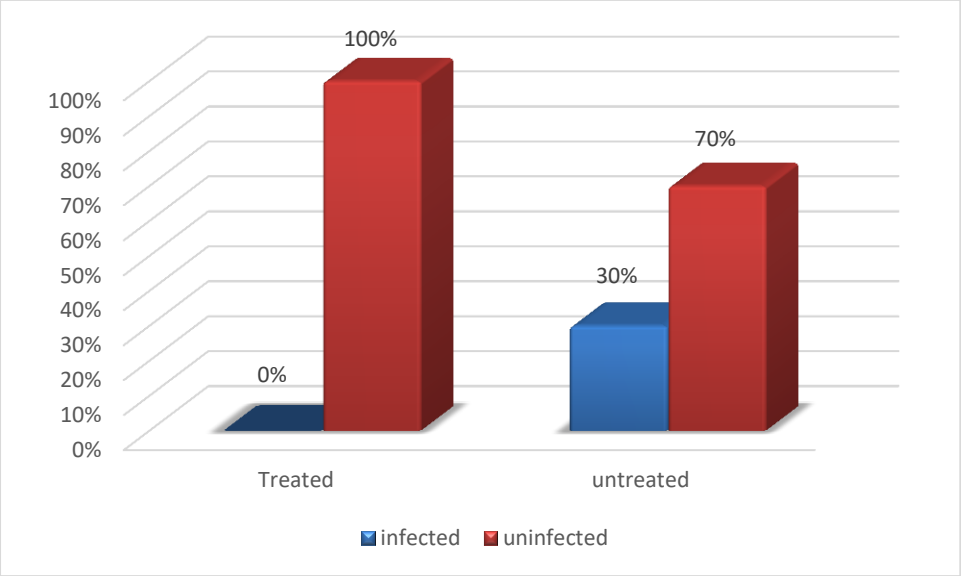


Figure 33: Prevalence of haemoparasite by treatment.

Discussion

This part will focus on the discussion of the results obtained by the different methods and techniques used and all types of indices used for the different categories of parasites: ectoparasites and haemoparasites of camel's bloods in the Laghouat region between December 2022 and june2023.

In Algeria little work has been done on parasitic infestations of camels and they have become much more interested in ectoparasites. As a result identification ectoparasites and blood parasites, were discussed in order to compare parasitic diversities in camels.

The ectoparasites identified belong to the arthropod branch it indicates a fauna basically constituted by the Ixodids (ticks). Among the ticks identified, found *Hyalomma impeltatum spp* this is less than the *Hyalomma dromedarii spp.*

The blood smears revealed the presence of 3 haemoparasites *Theileria spp, Babesia spp* and *Trypanosoma spp*. All of the following studies corroborate our findings.

Ectoparasites

In the Laghouat region, camels are preferred hosts for certain species of ticks. A total of 187 ticks were collected from 32 camels more than **(BEN YOUCEF et LABIDI 2017)** in EL oued with 116 ticks in 21camels **,** and less than **Abdullah Daria et al2018** in Saudi Arabia with 116 camels inspected, 79 were 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* is the most with a prevalence of **28%** in the study aerie. Higher results were recorded on dromedaries by **(BEN YOUCEF and LABIDI 2017)** in ELoued Algeria and **Van Straten and Jongejan (1993)** in Egypt (**95.6%**), **Idris and collaborateurs (2000)** in Oman (**89.55%**) and **Antoine-Moussiaux and collaborateurs (2005)** in the Agadez region of Niger (**100%**), and **Alireza Sazmand2017** in Iran with **85.5%.** Agree with **BOUHOUS (2006)** in Adrar (**99.41%**). As well as the work of **El GHALI et HASSAN(2009**) in northern Sudan, where this species is largely dominant (**89.0%**)**.** This 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).** We also note other results the overall prevalence of mange mite infestation ranges from 10.7% to 94.1% in camels from Ethiopia **Chalchisa andal2023.**

During our study we had higher prevalence of *Hyalomma dromedarii* **86.63%**, more than result of **Mohamed Gharbi2013** in central Tunisia **45%**, and *Hyalomma impeltatum* with **13.36%** less than **Mohamed Gharbi 2013** with **53%**. from Iran where **90.7%** of the ticks identified were *Hyalomma dromedarii* **(CAMPOUR et al.,2013)** more than our results.

In this study, we had identify a higher prevalence 86.63% of the infection by *H. dromedarii*, devised to16.66% females and 33.83% males, meanwhile13.36% infected by *H. impeltatum* 50% ifected females and 36% males.we noted that **Abdullah Daria et al,2018** in Saudi Arabia found 27.5% *H. dromedarii* male, and 14.2% female with total 41.7% ,in other side *H. impeltatum* with total 12.8% devised in to 11% males,1.8% females.

In this study, among the results mentioned, we had cases of poly parasitism, which is to say single infestation (*Hyalomma dromedarii*) **19.45 %** and double infestation *(Hyalomma dromedarii+Hyalomma impeltatum*) **8.75 %**.

We discussed our results according to selected criteria: the different categories of parasite, sex, age, treatment, health status, mode of breeding, purpose of breeding, study site, type of food.

In addition, the degree of parasitism is more marked in females **30.1%** than in males **21. 9%** which is perfectly consistent with the results found by **Bouhous et al (2008)**. However, other authors stated females are more affected than males **(Ashraf et al., 2014 and Megersa, 2014).** Also consistent with the results found by **Hamlili 2022 in Algeria** with33%infected females and 9%males infected, also agree with **Abdullah Daria et al2018** in Saudi Arabia with71%infected females which is higher than us (30.1%), and 59.3%males infected also more than us (29.1%). Except, our result is not in agreement with the observations of **Morel et collaborators (2000)** who reported that ticks are usually more common in males than in females.

For the relationship between camels age and ectoparasite levels indicates that adult 27.3% were less infected than young 31.3%. As we can see similar to our results, some authors reported young animals were more affected due to lower immunity than adult camels **(Saber, 2015).**

The infestation rate for untreated farms 35.6% is higher than treated farms 0%.

Studies of the relationship between the types of breeding of our camels with the rate of ectoparasites indicate that the sedentary mode was only infested 76.2%.

The study of the prevalence of ectoparasites according to production shows that farms intended for production (milk and all) accounted for 35.6% infected.

The study of the prevalence of ectoparasites according to mixed breeding 74.4% camels is infected.

The study of the prevalence of ectoparasites according to the study site shows that the breeding of the Ain madhi region had the highest prevalence of ectoparasites 90.9% and in the Kheneg region 85.7%.

Prevalence of ectoparasites by type of foods shows that (natural plants barley wheat and all) had the highest prevalence at 88.9%.

The results show that (rearing mode, mixed, type of diet, study site, treatment, age, sex, clinical status) have no significant influence ($p>0.05$), while production is have a significant influence on the prevalence of ectoparasites ($p<0.05$).

Haemoparasites

The overall prevalence of haemoparasitic infection in camels was found 24.34% which is higher than 14.2% previously reported by **Kamani et al. (2008),** lower 79.0% reported by

Rabana et al. (2011) in Maiduguri Nigeria, less than **Wakil et al2016** with 60.4% in Nigeria the results of **Tarek R Abou El-Naga2016** with 77.34% in Egypt higher than our results

Amongst the haemoparasites found in the studied camels *Babesia spp, Theileria spp and Trypanosoma spp* were found at different prevalence rates of 24.34%, 14.78% and 2.6% respectively in a descending order of frequency. Wich less than marked in Egypt of the 331 camels were examined for presence of blood parasites, prevalence of trypanosome 168 (50.8%), *Theileria spp* 157 (47.4%), and *Trypanosoma spp* 67 (20.24%) **Abou El-Naga2016.**

Our result shows a high prevalence of the infection by *Babesia spp* 24.34%, compared to previous microscopically findings reported in camels from Egypt (11.8%) **(El-Naga & Barghash, 2016)** and less than in Nigeria (24.3%) **(Wakil et al., 2016).** Similarly, the molecular prevalence of *Babesia spp*. among Iranian camels (6.6%) **(Khamesipour et al., 2015)** was less than that estimated in our study, also less than results of **Ahlam Ahmed et al 2022** with 5% in Egypt. although the occurrence of babesiosis in our study is higher than 13.17% reported by **Swelum et al., (2014)** in Saudi Arabia.

Also agree with **Jasim et al 2022** with 14.8% infected by *Theileria spp.*

Microscopic examination of the smears, allowed finding the presence of *Trypanosoma spp* in 3 females 2.6% which is less than 7.4% results found by**(Allali and Khader, 2021)** in Djelfa, which reveals a higher prevalence about 11.11%, with **Ehab Mossaad2017** in Sudan.

The prevalence of the infection by trypanozoma in our results 2.6%,was less than that reported in camels from the governorate of Tataouine (10.6%) **(Lachtar et al., 2017)** and in cattle from northern Tunisia (10.6%) **(Sallemi et al., 2018).**

During our study, we noted that in results mentioned, we had cases of poly parasitism, which is to say single infestation (*Babesia spp*) **7.82%**, and double infestation (*Babesia spp+Theileria spp*) **13.91%** meanwhile only **1,74%** infected by both of (*Babesia spp+Trypanosoma spp*), **0,87%** for triple infestation(*Babesia spp+ Theileia spp+ Trypanosoma spp).*

We discussed our results according to selected criteria: the different categories of heamoparasites, sex, age, treatment, health status, mode of breeding, purpose of breeding, study site, type of food.

The relationship between the sex of the camels studied and the rate of haemoparasites showed that the infestation of females 21.7 % was less than males 28.1 %, In Egypt females 67.2%, and males 35.3% (**Abou El-Naga2016).**

For the relationship between camels age and haemoparasites levels indicates that adult 23.2 % were less infected than young camels 25 %. In Egypt we mentioned adults were more infected with 76.2% than young's with 51.6% **(Abou El-Naga2016)**

The infestation rate for untreated farms 30% is higher than treated farms 0%.

Studies of the relationship between the types breeding of our camels with the rate of haemoparasites indicate that the sedentary mode was more infested than transhumance and nomadic 47.6%, 13%, 0%.

The study of the prevalence of the infection by haemoparasites according to production shows that farms intended for production (milk and meat) 0%, and (milk and all) 30%.

The study of the prevalence of the infection by heamoparasites according to mixed breeding 46.5%, and unmixed 9.7% infected.

The study of the prevalence of heamoparasites according to the study site shows that the breeding of the Ain madhi region had the highest prevalence of haemoparasites 72.7%, in the Kheneg region 28.6%, and finally in Tadjrouna 13%.

Prevalence of haemoparasites by type of foods shows that (natural plants barley wheat and all) had the highest prevalence at 55.6%, and 13 %(natural plants barley wheat).

The results show that (rearing mode, mixed, type of diet, study site, age, sex, clinical status) have no significant influence ($p>0.05$), while production ($p=0.07$) and treatment ($p=0.002$) have a significant influence on the prevalence of haemoparasites ($p<0.05$).

Conclusion, recommendation and perspectives

Conclusion, recommendation and perspectives

Camels (*Camelusdromedarius*) are a mammal that expresses abilitiesit is able to survive, reproduce and even produce (meat, milk, etc.) in a resource-poor environment. However, it could be affected by various pathologies; parasitic diseases (external or internal) are also considered among the health problems of this animal which they prove to harm its development and breeding.

Parasites have been studied for a very long time, most of the knowledge concerns parasites of medical or veterinary interest. Despite, their omnipresence within the living world, the role of parasitic infections on populationsis still very poorly controlled.

In Algeria, studies conducted in the search for parasites on the dromedary are rare and are generally carried out in the Saharan regions of the country which contain the majority of national camel population. The steppe is a pastoral region where camel breeding is a secondary activity (predominance of sheep breeding). In this regard, it would be more interesting to study the status of parasitic camel fauna in the steppe region of Algeria and as example Laghouat region. In this sense, this study was undertaken on a sampling of randomly selected animals; the work was done in a territory of Laghouat for a period of 7 months. Therefore, the objective is to highlight and determine the different ectoparasite and haemoparasite parasitic pathologies in camels and their influences on the health of animals.

Our work, which covers the identification of ectoparasites and haemoparasites of camels in the region of Laghouat during the period from December 2022 to June 2023, in total 115 camels from different sites in the Laghouat were tested and collected, at the zoology laboratory, allowed us to identify different species by the special techniques.

The use of M.G.G.staining, revealed the presence of 3 species of blood parasites: *Theileriaspp, Babesiaspp* and *Trypanosoma* spp.

The identification of ectoparasites show there are two species: *Hyalomma dromedarii* witch is dominant and *Hyalomma impeltatum.*

The lack of treatment and use of insecticides also contribute to this problem. Ticks are the most answered, was the most commonly found as ectoparasite on camels however the prevalence of ectoparasite infestation was influenced by various factors such as the type of breeding, the climate, sex, and lifestyle of the camels in general and the reason for rearing (the milk and meat) and the lifestyle of the breeders and the veterinary control in the urban area slightly decreases the degree of infestation.

The lack of food resources and water in the rural area especially in the dry period; promote contact with animals at watering and collective grazing promoting the spread of ticks, sarcoptic infestation.

Several ecological factors influence tick survival and development in particular temperature, wind, relative humidity and vegetation cover.

In the future, it would be necessary to conduct this study at the level of the whole national territory, to take into account the size of the sample, as well as the age, sex, race and physiological state of each camel. Furthermore, the use of specialized methods and techniques for the identification of each parasite species, such as PCR and histological sections, in order to establish a complete inventory of what camel can host as a parasite in Algeria.

In the end of this study we recommend:

- More sophisticated diagnostic techniques should be used in prevalence estimation and strain identification.
- Biology of the parasite and interaction with host pathogen should be studied for each specific geographical area.
- The dynamics of mechanical transmission of camel trypanosomiasis in endemic areas has to be thoroughly studied by including those factors contributing to occasional outbreaks.
- Avoid mixed breeding with small ruminants, to avoid the multiplication of parasites.
- Develop preventive strategies adapted to environmental conditions.
- Raising awareness of farmers and breeders of the need to take vaccinations and routine veterinary examination.

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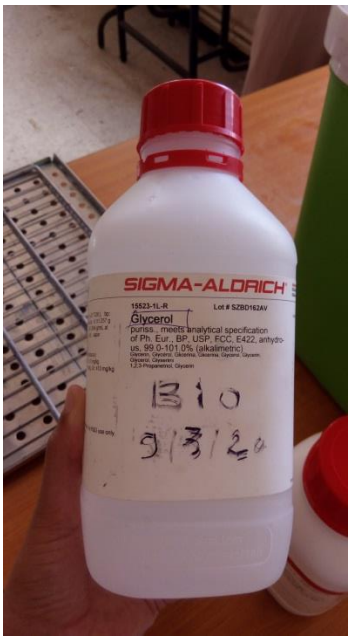
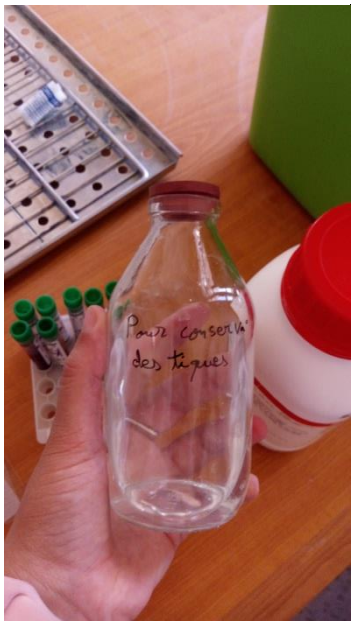
Annex

Appendix 01: Laboratory Equipment.





Annex

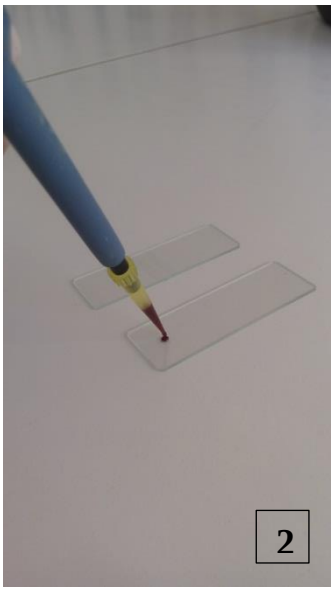

SIGMA
63590-1L
May-Grünwald solution
for the staining of blood constituents

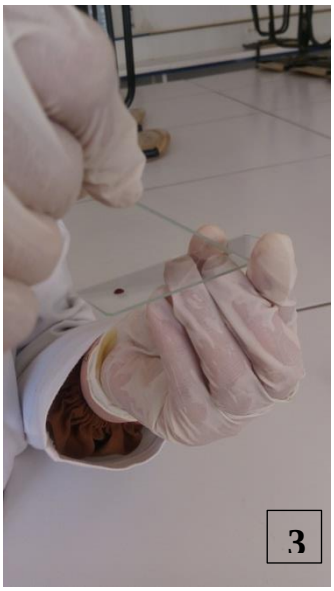

Discovery.V8
SteREO

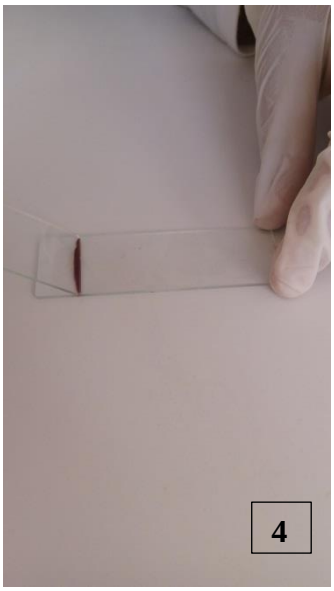

Lithium Heparin 4 ml

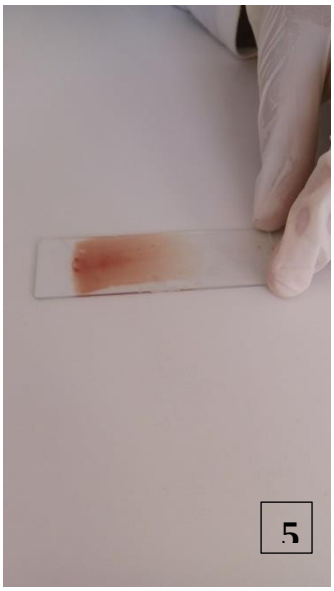

Age/Sex
Ward
Date

Annex 02: Blood smear preparation.

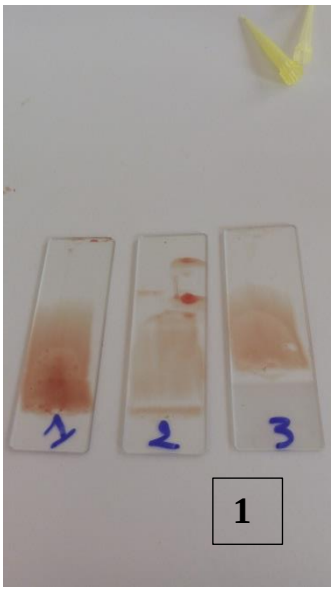


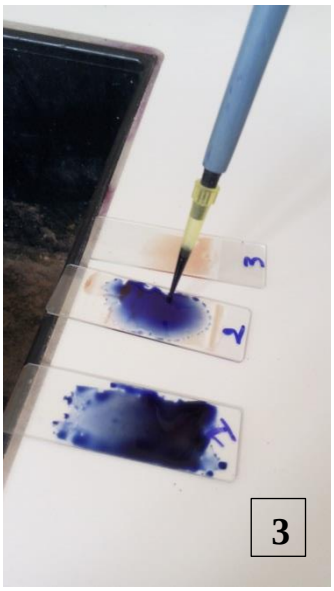


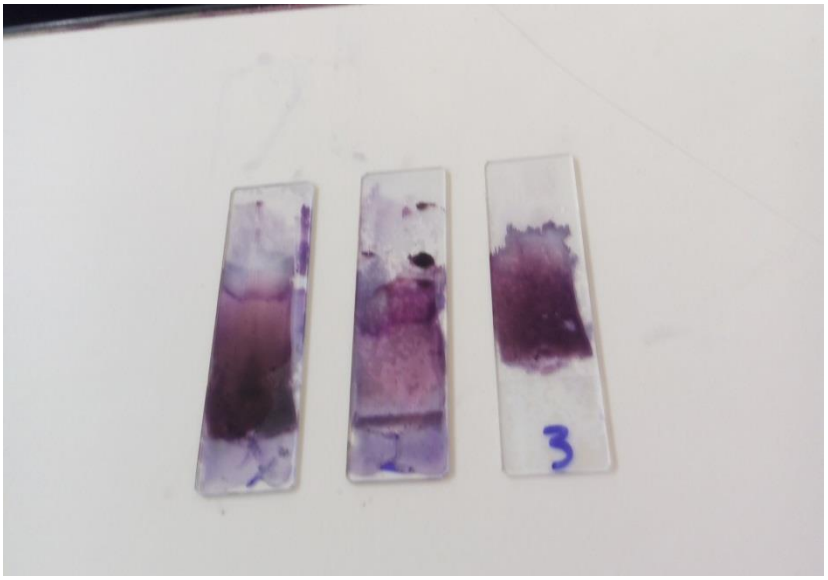


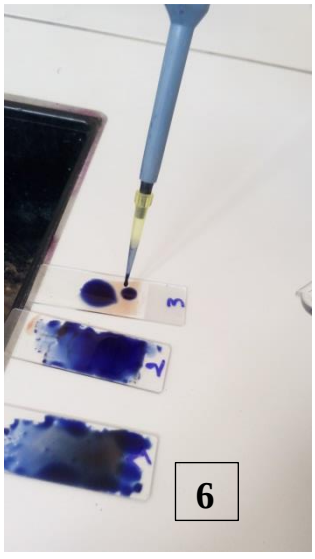


Annex 03 : Blood smear staining by MGG







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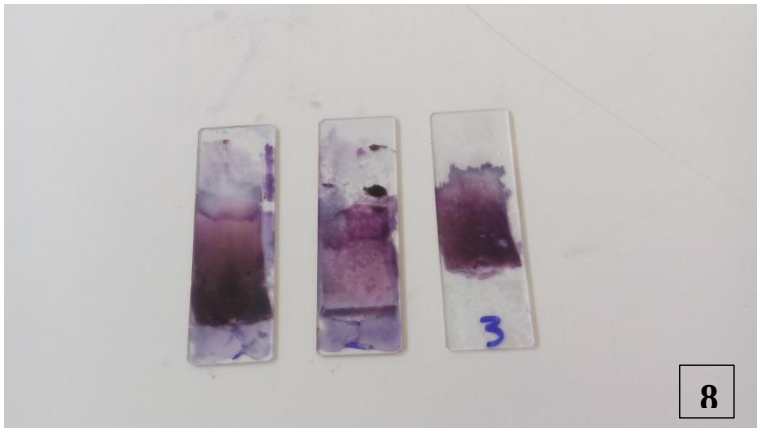
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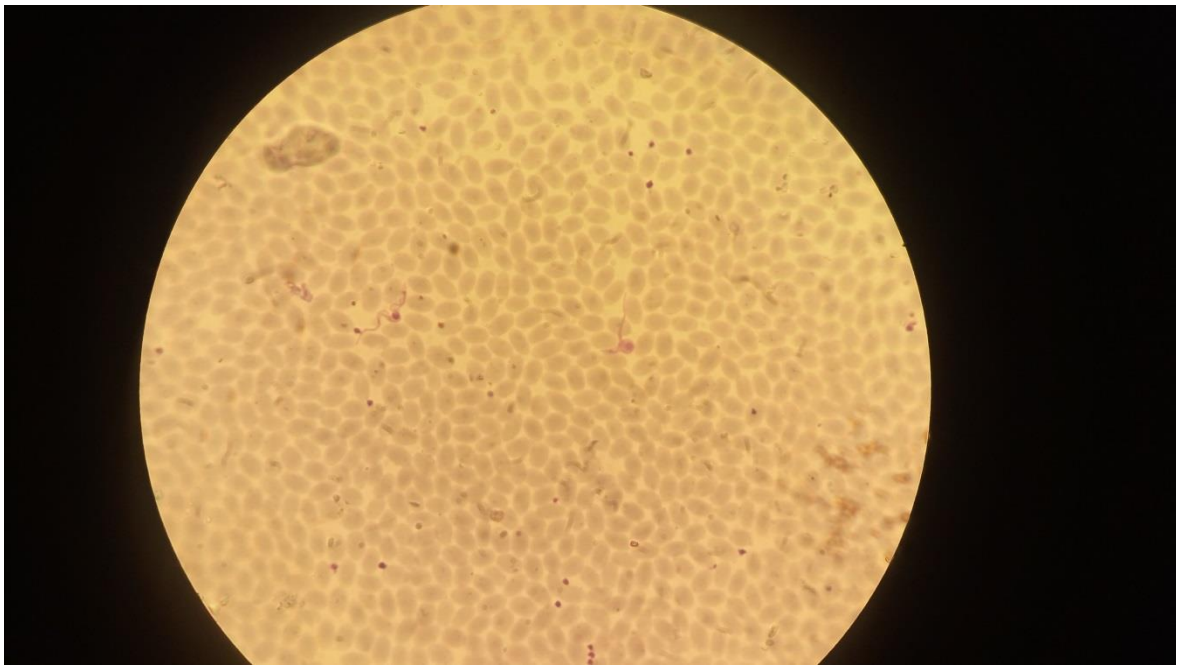
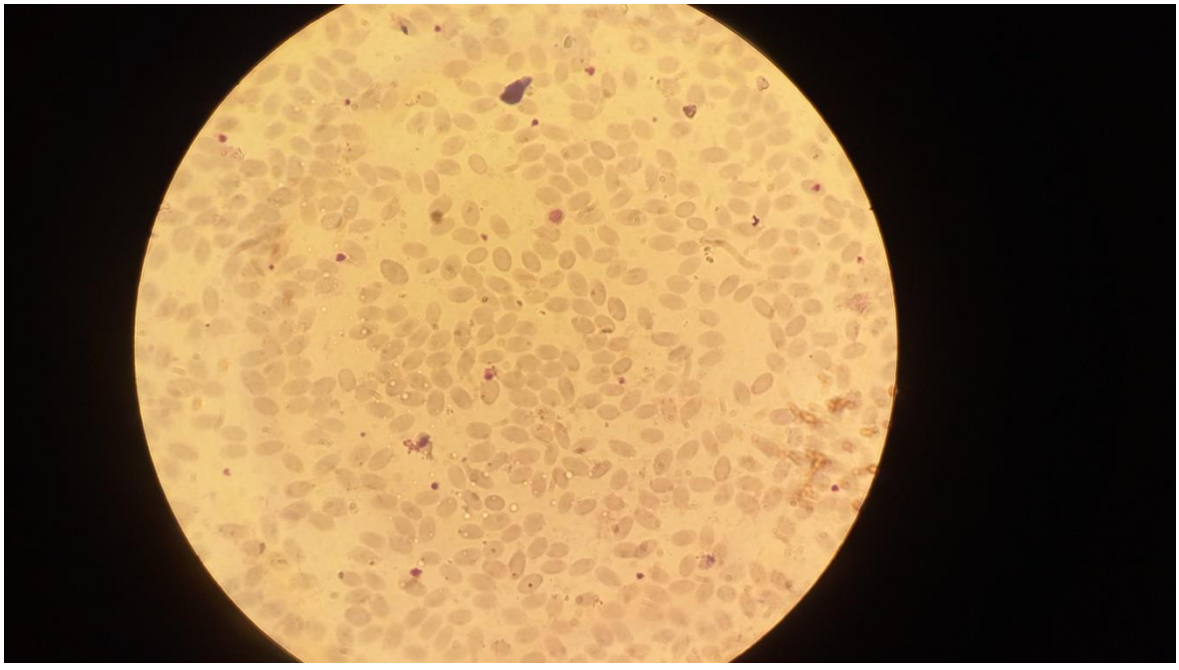
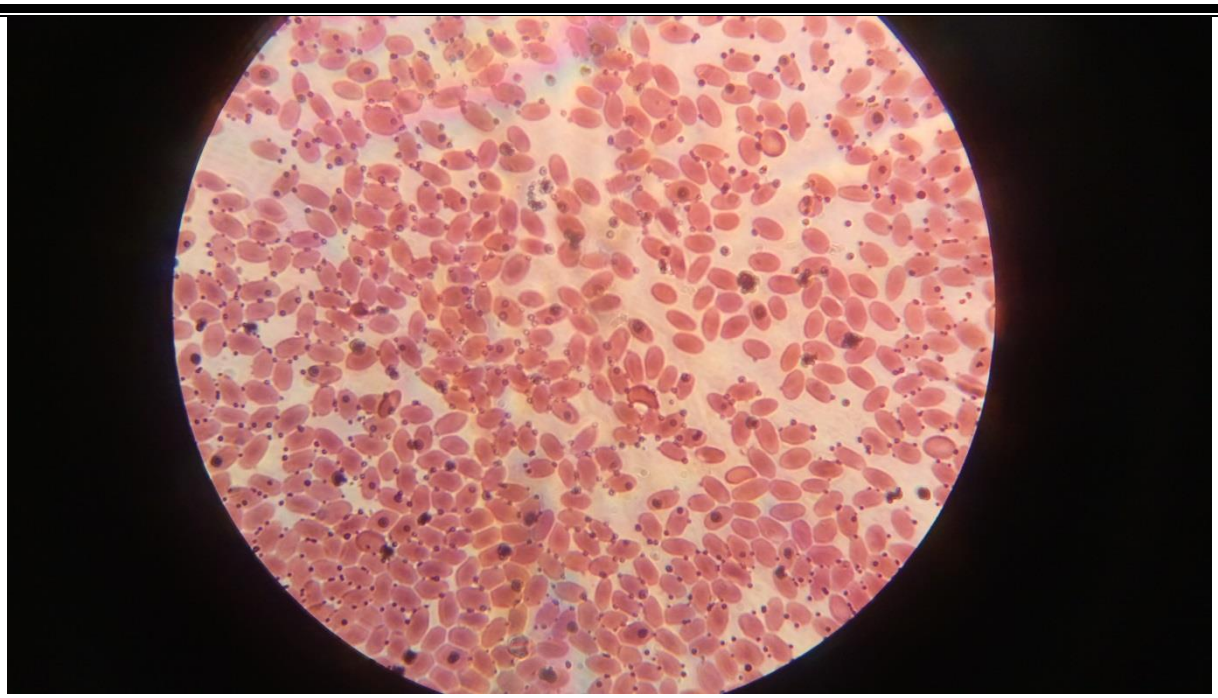
Annex 04



Trypanosoma spp



Babesia spp



Theileria spp